SCIENCE

[Entered at the Post-Office of New York, N.Y., as Second-Class Matter.]

A WEEKLY NEWSPAPER OF ALL THE ARTS AND SCIENCES.

SEVENTH YEAR.
VOL. XIV. NO. 357.

NEW YORK, DECEMBER 6. 1889

SINGLE COPIES, TEN CENTS.
$3.50 PER YEAR, IN ADVANCE.

THE FORWARD GAS-ENGINE.

THE more thoughtful among us will welcome any improvement in the arts which will modify the conditions under which motive power is available, and render it more accessible to small establishments whose existence depends upon the closest economy in all directions. One means of attaining this end is the introduction of gas-motors into these small industries. The great care and attention which have been paid to economic conditions in Europe have caused this subject to receive more consideration there than in this country: hence many important improvements in this class of machinery have found their origin and their greatest field among our transatlantic kindred. The sharp rivalry, however, engendered among them by the great demand, has stimulated efforts to perfect these motors, which have finally resulted in the group of inventions, patented both in Europe and America, by the producers of the Forward gas-engines. This motor has only been on the market for about a year in Europe, but is rapidly coming to the front. It was exhibited at the recent electrical and industrial exhibition at Birmingham, where, we are informed, it received the only gold medal for excellence of construction in gas-engines, as well as the only medal awarded gas-engines for electric lighting, although the other leading motors of the same class were well represented. It is now for the first time presented in the form of a business enterprise on this side of the Atlantic.

The distinguishing feature of this engine is a rotating valve by which the ignition of the combustible charge in the cylinder is effected. In the valve are eight ignition ports, which come into action successively. Each port, having performed its duty, makes a complete revolution before it comes into action again, and in the mean time is exposed to the air, by which the greater part of the heat which it has absorbed is carried away. This insures the cool working of the valve, which runs scarcely any risk of cutting, while the constant motion in one direction affords another element of safety. Every time the cylinder takes in a charge, the valve gives a partial revolution; but, when the gas is cut off completely, the valve ceases to move, and the small firing charge, which would otherwise be wasted, is saved. The number of missed explosions, however, is not great in this engine, as the strength of the charge is reduced as the work falls off, until it approaches the point at which it would cease to explode; the gas is then cut off entirely, and the valve left stationary until the governor arms again fall.

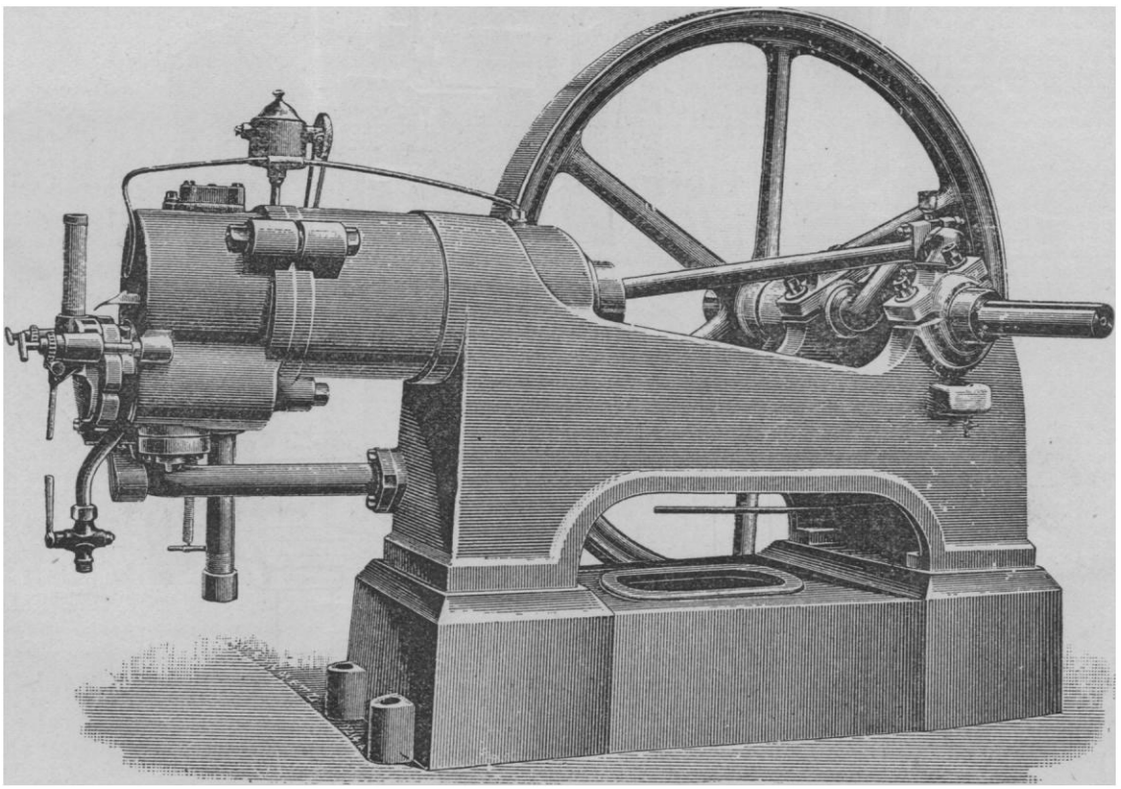

FIG. 1.—THE FORWARD GAS-ENGINE.

The mechanical devices by means of which these operations are performed are shown by the accompanying illustrations. Figs. 1 and 2 are perspective views of a 4-horse-power engine; Fig. 3 is an outline of the working parts, looking from the crank-shaft; and

Figs. 4 and 5 are plan and sectional views of the ignition valve. The valve *a* (Figs. 3, 4, and 5) is mounted on a pivot at the rear of the combustion chamber of the cylinder, and has a number of ratchet-teeth (*e*) around its circumference. It is rotated by a pawl, *l*, worked by a small crank at the end of the side shaft, and a connecting link, *n*. The cylinder being charged with compressed explosive mixture, the port *d* is also charged with the gaseous mixture. The disk *a* is, by the intermittent motion imparted to it, brought into position at the required time for igniting the mixture in the cylinder. The slot or small gas-chamber *f g* in the disk *a*, which is approaching the port *d*, receives inflammable gas from the fixed gas-duct *j* in the cover *b*, the passage j^2 in the rotating disk *a* being brought opposite during the motion of the said disk, and communicating with the duct or curved slot *j* in the cover *b*. The

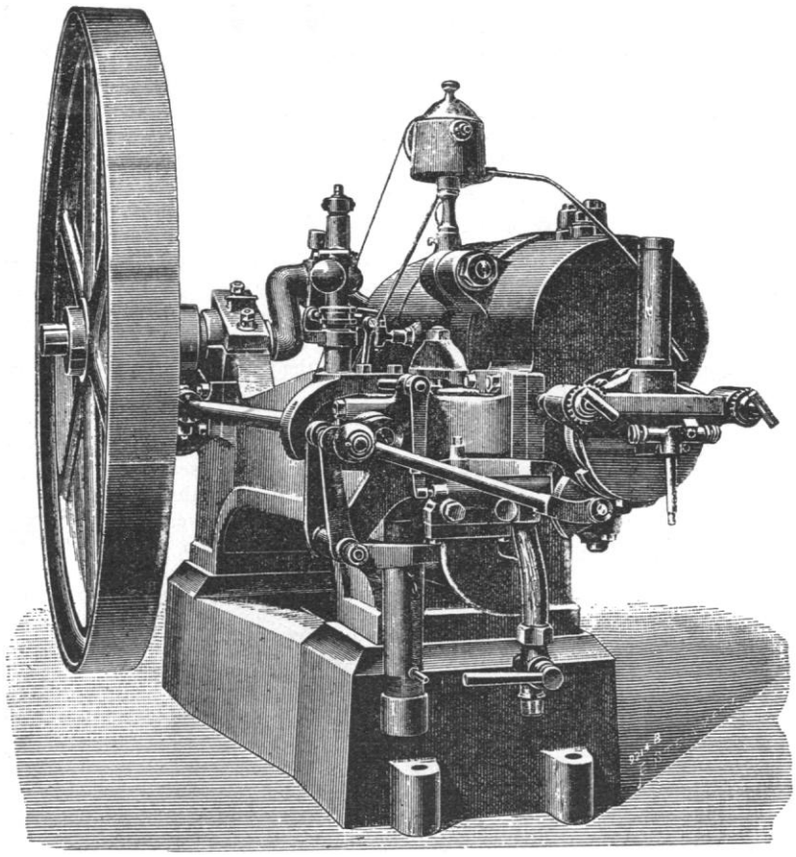

FIG. 2.

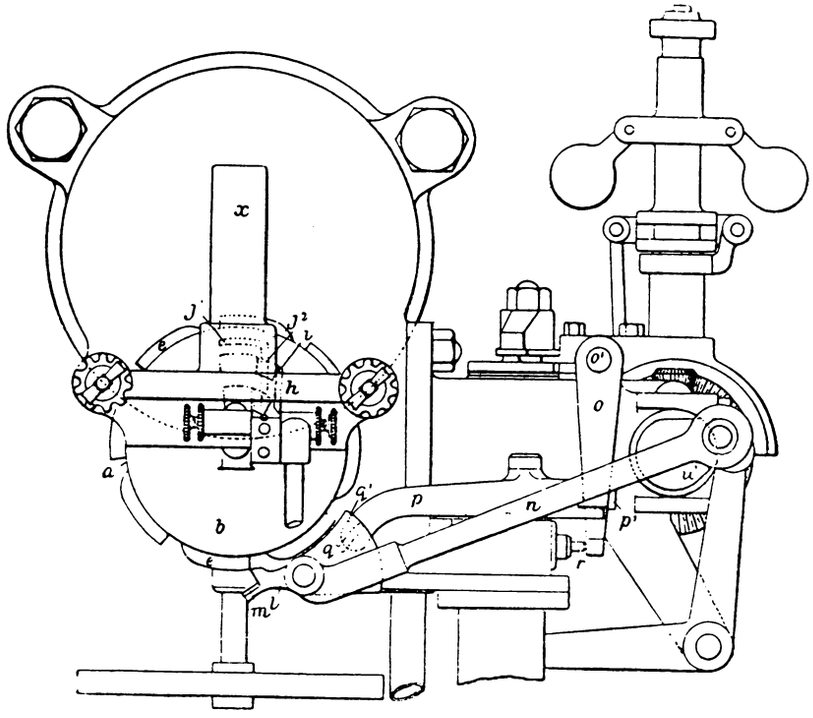

FIG. 3.

slot or small gas-chamber $f\,g$ receives atmospheric air to form an inflammable mixture with the gas in the small chamber through the duct f^2 in the fixed cover b, which duct f^2 communicates with the port g of the small gas-chamber $f\,g$.

By the action of the ratchet motion the small gas-chamber $f\,g$ in the disk a, having been charged in the manner described, is carried rapidly forward, and the gaseous mixture therein is ignited by the fixed relighting gas-jet h^1. The igniting of the charge in the

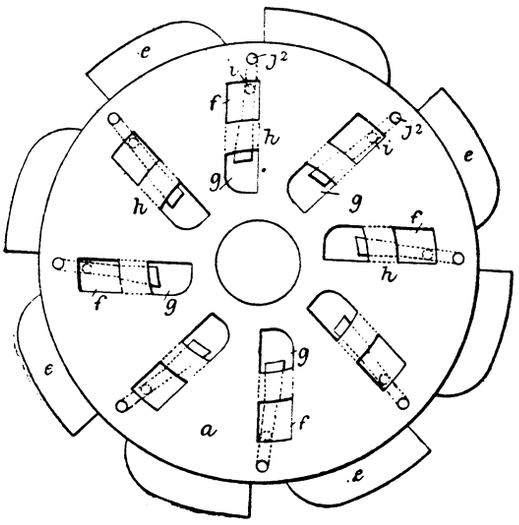

FIG. 4.

small gas-chamber $f\,g$ takes place immediately before the passage h comes opposite the port d into the gas-cylinder a^2. The passage h coming opposite the port d, the flame in the small gas chamber $f\,g$ ignites the gaseous mixture in the port d and the engine cylinder a^2. The passage h opens into the port g of the small gas-chamber $f\,g$ immediately after the small gas-chamber and the port f^2 are closed, the duct i communicating with the port d a little

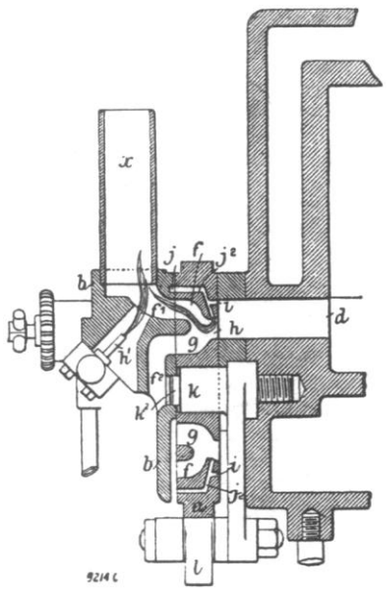

FIG. 5.

before the port h communicates with the port d to effect the ignition of the gaseous mixture in the gas-chamber or cylinder a^2.

The supply of gas is regulated by the lever o and the gas-valve r. The lever receives its motion through a spindle, o^1, from a second lever, which is acted upon by a cam on the side shaft. This cam is under the control of the governor. The lever o carries a cam, p^1, which engages with a lever, p, having at its end a stud, q^1, taking into a slot, q, in the pawl l. Upon the lever o moving so as to open the gas tappet-valve, the cam p^1 operates upon the lever p, causing the stud q to be disengaged from the slot, and allowing the pawl to fall into the teeth of the valve. When the engine is running so fast that the gas-valve is not opened, the stud holds the pawl out of gear.

This engine has been subjected to a series of tests by Professor R. H. Smith of Mason College, Birmingham, and has given most satisfactory and economical results. It was tried at full working load, at half load, and without load, the latter test being divided into three parts, — at fast, medium, and slow speeds. The full working load trial lasted 85 minutes, the speed being 176.86 revolutions per minute. The indicated horse-power was 5.54, and the brake horse-power 4.807, giving a mechanical efficiency of 0.8677. The gas consumed in driving the engine was 163.2 feet, or 20.79

FIG. 6.

Initial pressure	220 lbs. per sq. in.
Average mean pressure	77.73 " "
Revolutions per minute	175

cubic feet per hour per indicated horse-power, and 23.97 feet per brake horse-power. Fig. 6 shows an average indicator card taken during this trial; and Fig. 7, a high-pressure card, illustrating how the governor supplies a richer charge of gas when any sudden demand is made on the engine. At half-power, the brake horse-power was 3.084, equal to a gas consumption of 31.86 feet per horse-power per hour. The lighting jet burned about two feet an hour in both cases. When the engine was running empty, it burned 53 feet of gas per hour at the high speed, 44 feet at the medium speed, and 34 feet at the low speed. A comparison of these results with those obtained in the Society of Arts trial in England shows that the Forward gas-engine ranks very high in the matter of economy, while its mechanical simplicity is a great additional recommendation.

One of these engines, of 4 horse-power, is now on exhibition in

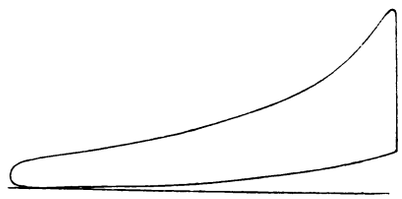

FIG. 7.

Initial pressure	165 lbs. per sq. in.
Average mean pressure	65.11 " "
Revolutions per minute	177

Boston, by the Forward Gas Engine Company, who, we understand, control the patents for this country, and will soon begin their manufacture.

A DANGEROUS INSECT PEST IN MEDFORD, MASS.

MR. C. H. FERNALD of the Division of Entomology of the Hatch Experiment Station of the Massachusetts Agricultural College, Amherst, Mass., has issued a special bulletin on "A Dangerous Insect Pest in Medford," known as the gypsy-moth (*Ocneria dispar* L.). On the 27th of last June, during his absence in Europe, several caterpillars were received at the station from Hon. William R. Sessions, secretary of the Board of Agriculture, with the request for information as to what they were, and the best methods of destroying them. These caterpillars were brought into the secretary's office by Mr. John Stetson of Medford, Mass., who stated that they were very destructive in that town, eating the leaves of fruit and shade trees. Mrs. Fernald, who had charge of the entomological work during Mr. Fernald's absence, determined the insect to be

the gypsy-moth (*Ocneria dispar* Linn.) of Europe; but as the moths were emerging, and laying their eggs for next year's brood, there was nothing to recommend at that time except to destroy the moths and their eggs as far as possible, and prepare for the destruction of the caterpillars when they first appear next spring.

There is a statement in the second volume of the *American Entomologist*, p. 111 (published in 1870), and also in Riley's "Second Missouri Report on Insects," p. 10, that "only a year ago the larva of a certain owlet moth (*Hypogymna dispar*), which is a great pest in Europe both to fruit-trees and forest-trees, was accidentally introduced by a Massachusetts entomologist into New England."

Mr. Samuel Henshaw and Dr. Hagen of Cambridge both state that the entomologist who introduced this insect was Mr. L. Trouvelot, now living in Paris, but at that time living near Glenwood, Medford, where he attempted some experiments in raising silk from our native silk-worms, and also introduced European species for the same purpose.

It seems, then, that this was an accidental introduction, but that they have now become acclimated, and are spreading, and doing so much damage as to cause very great alarm.

The gypsy-moth is abundant in nearly all parts of Europe, northern and western Asia, and it even extends as far as Japan. In this country it occurs only in Medford, Mass., occupying an area in the form of an ellipse about a mile and a half long by half a mile wide. This represents the territory where the outbreak occurred, and where the insects were very abundant. Without doubt, they are distributed in smaller quantities outside of this ellipse, but how far it is now impossible to tell.

This insect was reported as feeding upon the leaves of apple, cherry, quince, elm, linden, maple, balm of Gilead, birch, oak, willow, wisteria, Norway spruce, and corn. The food-plants given in Europe are apple, pear, plum, cherry, quince, apricot, lime, pomegranate, linden, elm, birch, beech, oak, poplar, willow, hornbeam, ash, hazel-nut, larch, fir, azalea, myrtle, rose, cabbage, and many others. Curtis, in his "British Entomology," states that they are sometimes very destructive in gardens. Professor W. P. Brooks reported this insect as very abundant in Sapporo, Japan, in 1883, and gave strawberry as a food-plant in addition to those mentioned above.

The fact that this insect has now been in this country for the last twenty years, and has not only held its own, but has multiplied to such an extent as to cause the entire destruction of the fruit-crop and also to defoliate the shade-trees in the infested region, is sufficient cause for alarm. The citizens of Medford are immediately interested, but the entire Commonwealth and country are threatened with one of the worst insect pests of all Europe. In 1817 the cork-oaks of southern France suffered severely from the attacks of this insect. One of the papers of that time stated that the beautiful cork-oaks which extended from Barbaste to the city of Podenas were nearly destroyed by the caterpillars of the gypsy-moth. After having devoured the leaves and young acorns, they attacked the fields of corn and millet, and also the grass-lands and fruit-trees.

In 1878 the plane trees of the public promenades of Lyons were nearly ruined by this same insect. Mr. Fernald states that only last summer he saw the moths in immense numbers on the trees in the Zoölogical Gardens of Berlin, where the caterpillars had done great injury; and the European works on entomology abound with instances of the destructiveness of this insect. When its long list of food-plants is considered, it will be seen how injurious this insect may become if allowed to spread over the country, and become established.

The opinion was expressed to him by prominent entomologists in Europe, that, if the gypsy-moth should get a foothold in this country, it would become a far greater pest than the Colorado potato-beetle, because it is so prolific, and feeds on so many different plants, while the potato-beetle confines itself to a small number.

In Europe eleven species of the *Ichneumonidæ*, and seven species of flies (*Tachina*), have been known to attack the eggs and caterpillars of this moth; but it is not known that there are any parasitic insects in this country that destroy it. Undoubtedly our predaceous beetles and bugs destroy more or less of them, and mud-wasps and spiders are also to be counted among their enemies.

All the masses of eggs should be scraped from the trees and other places where the females have deposited them, and burned. Crushing is not sufficient, as possibly some might escape uninjured. This should be done in the fall, winter, or early spring, before the eggs hatch. It is not at all probable that one will find all the egg-masses even with the most careful searching on the trees in a small orchard; but, when one remembers that this insect deposits its eggs on all kinds of shade and forest trees also, it appears a hopeless task to exterminate this pest by an attempt to destroy the eggs. It is a habit of these caterpillars, after they have emerged, to cluster together on the trunks or branches of the trees between the times of feeding, and this affords an opportunity of destroying vast numbers by crushing them; and after they have changed to pupæ they may be destroyed wherever they can be found. The female moths are so sluggish in their flight, and so conspicuous, that they may be easily captured and destroyed as soon as they emerge; yet any one or all of these methods which have been employed in Europe are not sufficient for their extermination. At best they will only reduce the numbers more or less, according to the thoroughness with which the work has been done. Mr. Fernald could not learn that any attempts have ever been made in Europe to destroy this insect by means of poisonous insecticides, and it is to this method that we may look for positive results in this country.

If all the trees in the infested region in Medford be thoroughly showered with Paris-green in water (one pound to a hundred and fifty gallons) soon after the hatching of the eggs in the spring, the young caterpillars will surely be destroyed; and, if any escape, it will be because of some neglect or ignorance in the use of the insecticide. It will be absolutely necessary to shower every tree and shrub in that region; for, if a single tree be neglected, it may yield a crop sufficiently large to eventually restock the region.

We can hardly feel confident that all these insects can be exterminated in one year; but if this work of showering the trees be continued during the months of April and May for two or three years under competent direction, we have no doubt but that they may be entirely destroyed.

This is, in the opinion of Mr. Fernald, the cheapest and surest method of exterminating this pest, but its effectiveness depends entirely upon the thoroughness and carefulness with which it is done; and those who do the work must have authority to shower the trees not only on public, but on private grounds.

As this insect was introduced into this country by an entomologist who carelessly allowed it to escape, the same thing may occur elsewhere if the people of Medford allow the eggs or caterpillars to be sent out of the town. The only proper thing to do with such a dangerous and destructive enemy is to burn it.

Several different common names have also been given to the insect in Europe, as the "sponge-moth," the "gypsy-moth," the "great-headed moth," the "fungus-moth," and others.

ELECTRICAL NEWS.

SPECIFIC INDUCTIVE CAPACITY. — Mr. W. A. Rudge writes on the above subject to *Nature* as follows: "On p. 669 of Ganot's 'Physics' (eleventh edition) the following statement is found: 'At a fixed distance above a gold-leaf electroscope, let an electrified sphere be placed, by which a certain divergence of the leaves is produced. If, now, the charges remaining the same, a disk of sulphur or of shellac be interposed, the divergence increases, showing that inductive action takes place through the sulphur to a greater extent than through a layer of air of the same thickness.' If this statement were correct, there should be less electric action on the side of the ball farthest from the electroscope when the dielectric is interposed. To test this, I arranged an experiment as follows: The knob of a charged Leyden jar was placed midway between two insulated plates of metal, each plate being in connection with an electroscope. The leaves of each electroscope now diverged to an equal extent. A plate of ebonite was now placed between the knob of the jar and one of the plates. If the statement above quoted is correct, the leaves of the electroscope in connection with this plate should show an increased divergence, but the reverse

effect was observed. The leaves partially collapsed. In all experiments that I have made by inserting dielectrics between a charged body and an electroscope, less electric action has been the result. If, while the charged ball be near the electroscope, the plate of it be touched with the finger, the leaves collapse; and on removing the finger, and then the charged ball, they again diverge. Now let a dielectric be placed between the ball and the electroscope, touch the latter, and remove the finger and ball as before, and much greater divergence will be produced. In both cases the electroscope is charged by induction. Without putting the electroscope to earth, I fail to see theoretically why any greater divergence should occur. I suppose some one must have made the experiment as quoted; but, if a greater effect was produced, it must have been caused by the substance used for a dielectric being charged itself. I have found very great difficulty in preventing plates of ebonite, paraffine, sulphur, etc., becoming electrified when placed near a charged body. I should like to know if any one has experimented in this direction, because either the text-books or myself must be wrong. In Guthrie's book (p. 101) there is a statement similar to Ganot's."

ELECTRIC LIGHTING AT BERLIN. — M. Wybau, a Belgian electrician, has recently read a paper before the Belgian Electrical Society on the electric lighting of Berlin, from which the following particulars of this important system are taken. At Berlin the electric light, as stated in *Engineering*, is supplied from a number of central stations, the two principal of which are situated in Markgrafenstrasse and the Mauerstrasse. Of the other stations, one lights the Kaiser Galerie, and the other a block of houses at the corner of Unter den Linden and Friedrichstrasse. A fifth station, of but small importance, supplies the lighting of Leipzigerstrasse. At the Markgrafenstrasse station there are eight steam-engines, each of 150 horse-power, which drive sixteen Edison dynamos. To this plant there have recently been added four compound inverted engines, each capable of indicating 300 horse-power, which drive direct four dynamos of 165 kilowatts each. These dynamos are of the multipolar type, and are slow-moving machines, their armatures making but eighty-six revolutions per minute in normal working. The boiler-house contains eight De Naeyer tubulous boilers, which supply the steam for the whole plant. In the switch-room is a rheostat of exceptionally large size, which is used to regulate the current in the distributing mains. These mains are eighty in number, most of which are with their coverings about 3 inches in diameter, and the greatest section of copper in any one of them is 800 square millimetres. At the Mauerstrasse station there are six boilers, three engines of 180 horse-power each, and three of 300 horse-power each. At the Friedrichstrasse station there are four engines of 60 horse-power each, and at the Kaiser Galerie four of 80 horse-power each. At the small station on the Leipzigerstrasse there are two engines of 80 horse-power. The floor space required in the above installations per 1,000 lamps for boilers and machinery is from 323 to 377 square feet. At the Edison station in New York about 194 square feet of floor space are required, but the dynamos and engines run at much higher speeds. The total length of cables laid in Berlin is about 170 kilometres, which are laid under the footpaths. In every case Siemens cables are used.

ELECTRICAL SUNSTROKE. — As a remedy against "electrical sunstroke," as the affection is called that attacks men exposed to the intense rays of the electric arc by means of which metals are fused and welded, is a veil or mask of glazed taffeta, supported by a wicker head-piece, and provided with goggles of gray glass.

THE HOUSTHOLM ELECTRIC LIGHTHOUSE. — This lighthouse, the most powerful electric lighthouse in the world, was opened a few weeks ago, and its working has given great satisfaction. Even in rainy weather its light has been distinctly visible at Blokhus, a straight distance of about thirty-five miles. The only undesirable incident attending the working of the new lighthouse is the immense number of birds which get killed, and which amount to thousands, comprising starlings, snipes, larks, etc., basketfuls being collected every morning in the vicinity of the lighthouse. As stated in *Engineering*, the lighthouse is 209 feet high, and the light-power in the beam is 2,000,000 candles. To guard against the stoppage of the light through any accident to the machinery, this is, as far as it has been possible, constructed on the twin principle. There are two engines, three tubular boilers, one of which is a particularly quick-heating one, two electro-magnetic machines with a joint capacity of 45 volts, 250 ampères, from Meritens & Co., Paris, two electric lamps, with various reserve lamps, etc. In connection with the lighthouse, and at a distance of respectively about 2,000 and 16,000 feet, are two powerful sirens, which are fed with compressed air from two air-pumps in the engine-house, and which can be coupled together with the engines. At the siren stations there are reservoirs of compressed air, which are worked by means of electricity and clock-work, and great care and forethought seem to have been bestowed upon the whole installation in all its details.

ELECTRIFICATION DUE TO CONTACT OF GASES WITH LIQUIDS. — At the meeting of the London Physical Society, held on Nov. 15, Mr. Enright read a paper on "The Electrification due to Contact of Gases with Liquids." Repeating his experiments with zinc and hydrochloric acid, the author, by passing the gas into an insulated metallic vessel connected with the electrometer, proved that it was always charged with electricity of the opposite kind to that of the solution. The electrical phenomena of many other reactions have been investigated, with the result that the gas, whether H_1, CO_2, SO_3, SH_2, or Cl, is always electrified positively when escaping from acids, and negatively when leaving a solution of the salt. In some cases, according to *Engineering*, distinct reversal is not obtainable, but all these seem explicable by considering the solubility and power of diffusion of the resulting salts. Various other results given in the paper tend to confirm this hypothesis. Seeking for an explanation of the observed phenomena, the author could arrive at no satisfactory one excepting "contact" between gases and liquids; and, if this be the true explanation, he hoped to prove it directly by passing hydrogen through acid. In this, however, he was unsuccessful, owing, he believes, to the impossibility of bringing the gas into actual contact with the liquid. True contact only seems possible when the gas is in the nascent state. Some difficulty was experienced in obtaining non-electrified gas, for the charge is retained several hours after its production, even if the gas be kept in metallic vessels connected to earth. Such vessels, when recently filled, form condensers, in which the electricity pervades an enclosed space, and whose charge is available on allowing the gas to escape. Soap-bubbles blown with newly generated hydrogen were also found to act as condensers, the liquid of which, when broken, exhibited a negative charge. This fact, the author suggested, may explain the so-called "fire-balls" sometimes seen during thunder-storms; for if, by any abnormal distribution of heat, a quantity of electrified air becomes enclosed by a film of moisture, its movements and behavior would closely resemble those of fire-balls. A similar explanation was proposed for the phenomenon mentioned in a recent number of *Nature*, where part of a thunder-cloud was seen to separate from the mass, descend to earth, and rise again. The latter part of the paper describes methods of measuring the contact potential differences between gases and liquids, the most satisfactory of which is a "water-dropper;" and by its means the potential difference between hydrogen and hydrochloric acid was found to be about 42 volts.

HEALTH MATTERS.

SALT AND MICROBES. — A foreign observer has carried out some instructive researches into the effect of salt on various pathogenic micro-organisms. He found, says the *Medical Press*, that the results varied a good deal, according to the particular microbe experimented upon. The cholora bacillus, for example, curled up and died in a few hours, while the bacillus of typhoid-fever and the micrococci of pus and erysipelas resisted its influence for weeks and even months. That part of his observations bearing on tuberculosis possesses a practical importance, owing to the custom in slaughter-houses of salting the flesh of animals recognized to be tuberculous, and exposing it for sale in the course of a few weeks. M. de Freytag has shown that the tubercle bacillus thrives in the presence of an excess of salt, and salting the tuberculous tissues of an ox in no wise prevented the infection of animals fed thereon: hence it is highly desirable that a stop should be put to a

practice which exposes those who partake of the diseased meat to such obvious risks of infection.

COOLING OF THE BODY BY SPRAY. — Dr. S. Placzek, following up some laboratory experiments by Preyer and Flashaar on the effect of spraying a considerable part of the body surface of animals with cold water, has applied the spray for the purpose of reducing febrile temperatures in human beings. In the case of a man suffering from phthisis, whose temperature was high, he found, that, by spraying about a pint of water at between 60° and 70° F. over his body, the temperature fell to normal, and continued so for several hours. Again, a similar method was satisfactorily applied in the case of a girl with diphtheria. In the healthy human subject, according to the *Lancet*, the spray lowered the temperature nearly two degrees, and, in animals which had been put into a condition of septic pyrexia by injections of bacteria, the temperature was reduced to normal by the spray. By keeping healthy guinea-pigs and rabbits some hours under spray, and using from half a pint to a pint of water at the temperature of the room (44° to 62°), the temperature of the animals fell several degrees.

DEATH BY ELECTRICITY. — At the meeting of the Medico-Legal Society held in this city Nov. 20. Dr. Phillip E. Donlin, deputy coroner, who read a paper on "The Pathology of Death by Electricity," in the course of which he said, "The popular idea that the electrical current passes along the nerves and produces shock by conducting the current to the brain, is, as you know, fallacious. Our knowledge of the great electrical conductive power of water, and the experiments of Dr. Richardson, which show the still greater electrical conductive power of blood, would lead one to suppose — and, in fact, it is proved by the greater damage done to the most vascular organs of the body — that the blood is the great conductor of electricity; and that in all cases of exposure to the electric current the blood is the first to suffer, and the nerve-centres and cells the last. Unquestionably our knowledge of the manner of death points out clearly, that, when death is not on the moment produced by the shock of the current, it must be produced by the electric current's action (conducted by the blood) upon the ganglia of the heart, causing spasm of the heart muscle, emptying the ventricles, and abnormally forcibly propelling the charged and fluid blood to the periphery, producing hyperæmic ecchymosis in the most vascular portions of the most vascular organs. Where death is not instantaneous, it must be produced by disorganization of the blood, interference with the circulation causing engorgement of some vital vascular organ. The lungs being the most vascular, death usually results from asphyxia either through the unoxygenated condition of the blood, or hyperæmia of these organs." In reply to a question as to the effect likely to be produced by the infliction of the death penalty by electricity, Dr. Donlin said that the immensity of the power of the machines constructed was such that the purely mechanical result would occasion death. It was possible with those appliances to drive the current of electricity through the tissues with such power as to destroy them, though the amount of power to be employed was clearly within the control of the electrician.

IS COLORADO'S CLIMATE CHANGING? — The inhabitants of Denver are asking what is the meaning of the unusual snow-fall and humidity of the past month. The newspapers of that city, as we learn from *Medical News*, have expressed the opinion that their climate is about to undergo a change, in consequence of surface changes of "building up" and improving the State. The present moist season has been especially disappointing to Eastern people, who have journeyed to Denver to escape the humidity of our seaboard winters. From a letter recently received, a few sentences are quoted: "Snow has fallen each night and morning, but the sun conquers by mid-day, making walking almost impossible. As a usual thing, the inhabitants expect about ten days of inclement weather during winter and spring, and have not looked upon the paving of streets and crossings as at all necessary. But they are now aroused to remedy this condition. The snow-fall is said by some to be already greater than the total for three ordinary winters." The total fall at the Denver station, in October, was 2.11 inches, and is the only October since 1871 when 1.49 inches have been exceeded, with the single exception of that of 1877, when 2.15 inches were registered. There have been but nine cloudless days in the same month, while nineteen were partly cloudy. The mean temperature has been somewhat above that of the past decade. Fog — a condition hitherto almost unknown in Colorado — occurred during five mornings in October.

CARE OF THE TEETH. — At the meeting in Berlin last spring, of the German Association of American Dentists, the best means of preserving the teeth were discussed, and Dr. Richter of Breslau said, "We know that the whole method of correctly caring for the teeth can be expressed in two words, *brush*, *soap*. In these two things we have all that is needful for the preservation of the teeth. All the preparations not containing soap are not to be recommended; and if they contain soap, all other ingredients are useless except for the purpose of making their taste agreeable. Among the soaps, the white castile soap of the English market is especially to be recommended. A shower of tooth preparations has been thrown on the market, but very few of which are to be recommended. Testing the composition of them, we find that about 90 per cent are not only unsuitable for their purpose, but that the greater part are actually harmful. All the preparations containing salicylic acid are, as the investigations of Fernier have shown, destructive of the teeth. He who will unceasingly preach to his patients to brush their teeth carefully shortly before bedtime, as a cleansing material to use castile soap, as a mouth wash a solution of oil of peppermint in water, and to cleanse the spaces between the teeth by careful use of a silken thread, will help them in preserving their teeth, and will win the gratitude and good words of the public."

THE DIGESTIBILITY OF BOILED MILK. — Though the importance of sterilizing milk for bottle-fed infants in cities has been proven beyond a doubt, the process seems to have some disadvantages. In a recent number of the *Zeitschrift für physiologische Chemie*, Dr. Randnitz publishes some striking experiments on the subject. He shows by analysis of the milk ingested, and of the fæces and urine, that much less nitrogenous material is abstracted from boiled than from unboiled milk. If 15.6 grams of nitrogen in the form of unboiled milk were given to dogs for three days, analysis showed that 9.4 per cent was stored in the tissues of the animal. On the other hand, with the same amount of nitrogen in boiled milk, but 5.7 per cent was assimilated. If these results are confirmed, it is evident that an infant must need a larger quantity of sterilized than of raw milk.

ARTIFICIAL FOOD FOR INFANTS. — Dr. Escherich of Munich gave a lecture in the pædiatric section of the sixty-second meeting of German naturalists and physicians at Heidelberg, advocating a reform in the artificial feeding of infants. He bases his belief in the necessity of such a reform on the errors produced by Biedert's theory, which depends upon the difference between cow's milk and normal human milk. Biedert's view was, as stated in the *Lancet*, that all the troubles and diseases occurring in artificially fed infants were due to the indigestion of the caseine of the cow's milk, causing irritation of the mucous membrane of the bowels. He therefore considered, that, if the latter were diluted so as to contain one per cent only of caseine, the infant could not possibly take an injurious quantity of this noxious substance. Dr. Escherich considers that this theory, and the practice resulting from it, have gone far to prevent due care being exercised as to much more important conditions. Such are, according to the lecturer, germs and fermentation in improperly kept cow's milk, the number of meals, and the quantity of food given at a time in proportion to the capacity of the infantile stomach, the total quantity of nutritious matter and its proportion in the food, and finally the injurious effect which the water which has been added to the food has on the digestion and the metamorphosis of nutritious matter. Dr. Escherich holds it, above all, necessary to return to physiological principles, and so to approximate artificial feeding as much as possible to the mother's milk, as regards the absence of germs and the number and quantities of meals. The lecturer then pointed out that it is easy enough, by sterilization of small quantities of milk according to Soxhlet's plan, to comply at least theoretically with all these conditions, and at the same time to limit the quantity of caseine so as to fulfil Biedert's requirements.

NOTES AND NEWS.

THE eighth congress of Russian naturalists and physicians will be held at St. Petersburg from Dec. 27, 1889, to Jan. 7, 1890.

— There are now thirty-nine crematories in various parts of the world. Italy has twenty-three; America has ten; while England, Germany, France, Switzerland, Denmark, and Sweden have one apiece. In Italy there were two cremations in 1876; the number rose to fifteen in 1877, and in 1888 the number was 226. Since 1876, 1,177 cremations have taken place in Italy, while the combined numbers in all other countries brings the total only to 1,269.

— The following is a list of the papers read at the meeting of the Royal Meteorological Society, London, Nov. 20: "Second Report of the Thunder-Storm Committee," being a discussion by Mr. Marriott on the distribution of days of thunder-storms over England and Wales during the seventeen years 1871–87; "On the Change of Temperature which accompanies Thunder Storms in Southern England," by Mr. G. M. Whipple; "Note on the Appearance of St. Elmo's Fire at Walton on the Naze, Sept. 3, 1889," by Mr. W. H. Dines; "Notes on Cirrus Formation," by Mr. H. Helm Clayton, who has made a special study of cloud-forms and their changes; "A Comparison between the Jordan and the Campbell Stokes Sunshine Recorder," by Mr. F. C. Bayard, being the result of a year's comparison between these two instruments; "Sunshine," by Mr. A. B. MacDowall, being a discussion of the hours of sunshine recorded at the stations of the Royal Meteorological Society; "On Climatological Observations at Ballyboley, County Antrim," by Professor S. A. Hill, the result of observations made during the five years 1884–88.

— A circular letter has been sent to the members of the National Electric Light Association by the secretary, Mr. Allan V. Garratt, asking them to state to him as briefly as possible the most difficult electrical problems they meet in their investigations or in the conduct of their electrical business. They are also requested to state what feature of their business is the least economical or efficient, and why, and where the greatest economy could be effected if the difficulty could be overcome. The answers to these queries will be digested, and the results submitted to Professor Henry A. Rowland of Johns Hopkins University. Professor Rowland has consented to address the next electric-light convention at Kansas City in February, basing his remarks upon the problems suggested by the members, and pointing out the direction in which their solution must be sought.

— From a memorandum appended to the last report of the United States consul at Shanghai, it appears that the greatest silk-producing province in China is Che Kiang, and Kiang-Su comes second. The two great divisions in silk as exported from central China are known in all places of consumption as *tsatlees* and *taysaams*. *Tsatlee* is simply the Cantonese for *tseih le* (or "seven li"); that is to say, an area of that dimension, taking Nanzing as the centre, where the best fine-sized silk was formerly produced. The radius has been extended, in consequence of the higher price paid for fine compared with coarse sorts; and *tsatlees* now include some silks reeled from Sinsze and Seloo cocoons, which formerly were only employed for silks of the coarser thread. Considerable quantities of *taysaams* are still, however, being reeled in the two last-named districts. At the present time *tsatlee* means silk produced at Nanzing, Chinza, Linglooh, Shwangling, Woochin, Leensze, Hoochow, and a portion of Sinsze and Seloo, besides the intermediate towns, all situated in Che-Kiang. *Taysaam* (meaning "a big worm") has really only the signification of silks of a coarse reeling, and under the denomination are classed silks from Kiahsing, Sinsze, Dongse, Shaouhing, Woosieh, and Laeyang, the last two districts being situated in Kiang-Su. Haining or Yuenfa, situate in Che-Kiang, produces silk reeled of the finest size known in China; and when native competition was crippled by the Tai-Ping rebellion, large quantities annually found a ready sale in Europe. Of late years, however, the export has dwindled down to almost nothing. Hang-Chow, also Che-Kiang, produces both fine and coarse sized silks, *tsatlees* and *taysaams*, the size of the former from this district very nearly approaching to that of Kiahsing *taysaams*, and they are generally in favor both for export and for home use, while the coarse sorts are mostly taken by Chinese. Shaouhing, in Che-Kiang, produces a very considerable quantity of silk, that, when reeled on foreign methods, is said to be equal to any in the empire, but which, as natives persist in reeling on a large wheel and without care, has gradually lost all interest to foreigners. Laehang, in Kiang-Su, produces from 3,000 to 4,000 bales annually, but the same remarks as those applied to the Shaouhing production must apply also to this district's production. The principal towns where throwing is carried on are Nanking, Soo-Chow, and Hang-Chow, and the business must be large to meet the requirements of the enormous piece-goods trade of China. Formerly foreigners used to export considerable quantities; but the improvements made in Europe which have not extended to China have extinguished the trade. The re-reeling of silks (for the purpose of rendering the manipulation of the silk easier to manufacture) is carried on in the centres of Nanzing and Chinza, and the outlying farms and hamlets. The production is considerable, and would be larger, it is said, if the Chinese would use greater care and abstain from adulterating the silk during the process.

— In response to a despatch from Emin Pacha, doubtless sent on to Zanzibar in advance of the main party, and thence cabled to Cairo, the Egyptian government steamer "Mansourah" has been sent to meet Stanley and Emin and their party at Zanzibar. This will hasten Stanley's return to Europe, and the completion of his adventurous three-years' task may be chronicled very soon. A long letter from Stanley to a friend, dated September, 1888, has just been published. It records his discoveries, and recounts the difficulties anticipated on his homeward journey. There is an account of the hostility of the King of the Kabburega, who stripped Casati, and turned him adrift to perish. He was fortunately found and rescued by Emin. Another letter gives a full account of his sojourn with Emin.

— The *Lancet*, commenting on the passage of the English infectious disease notification bill, says, "One thing is remarkable in this legislation, — the slight resistance which politicians of advanced views have been able to offer to its fundamental principle; viz., the right of the community to insist on knowing the affairs of individuals and families where these are likely to involve in any degree the health of others: in other words, the subordination of the individual to the community. This is, of course, the fundamental principle of society, but it is ever undergoing fresh development. National education, vaccination, isolation, and notification of disease, are all illustrations of the same principle. We have ourselves no hesitation in accepting the principle that individual liberty must give way where such doubtful advantages as the freedom to have small-pox and scarlet-fever are the only badges of liberty; and it will involve no misfortune to the world if many other rights claimed by well-meaning but discordant individuals are curtailed in the interests of society."

— The New York Electrical Society, the oldest body of the kind in the country, is the Electrical Section of the American Institute. The object of the society is to bring before its members such topics and new inventions as merit their study and attention. There is a large and rapidly growing class of those who wish to gain a greater familiarity with electricity, and it is to the education of this class that the society directs its work. There is another class, composed of those who, while not earning a livelihood from electrical work, are greatly interested in all the developments of electricity, and who are glad to attend the meetings of the society, because they there are given the opportunity to come into contact with practical electricians, from whom they may elicit instruction and information such as no book could impart. The appreciation of the work of the society in connection with this element of the community is shown by the growing attendance at the meetings, and by the readiness of the press to publish reports of the proceedings. During the present season the society will introduce to its members a number of the leading men in the electrical profession, who will handle the subjects with which they are most familiar, and of which they are acknowledged masters. From such a course of papers and lectures as has been arranged, there can be no doubt that a great stimulus will be given to the study and application of electricity in New York; and the society therefore confidently appeals to those in any way interested in electricity for all the support

that they can give. Among the papers and lectures already read this season are "Electrical Exhibitions, and a Description of Recent Electrical Developments in Europe," and "How to test Electric Motors." Among those yet to come are "Progress of Electric Railroads," "A Talk on Cables," "The Electrical Torpedo, — New York's Sole Defence," "Storage-Batteries," "The Incandescent Lamp," "The Telegraph," "The Telephone," "The Alternating Current," "The Galvanometer and its Uses," "Electricity in War," "Phantom Wires," "How to run an Electric-Light Station," "Transformers," "Power Transmission," "Laboratory Manipulations," "The Social Side of the Electric Street Railway," "The Solution of Every-day Electrical Problems," and "The Progress of the Year." The officers of the society are as follows: president, Francis B. Crocker; vice-presidents, Joseph Wetzler, Francis Forbes, and Dr. Otto A. Moses; secretary, George H. Guy; treasurer, H. A. Sinclair; trustees, J. M. Pendleton, C. O. Mailloux, and A. A. Knudson.

— It is well known, says *Nature*, that whales can remain a long time under water, but exact data as to the time have been rather lacking. In his northern travels, Dr. Kückenthal of Jena recently observed that a harpooned white whale continued under water forty-five minutes.

— For determination of the air-temperature at great heights, the Berlin Society for Ballooning, we learn from *Humboldt*, is going to try a method of Herr Siegsfeld, who uses a thermometer, which, by closure of an electric circuit when certain temperatures are reached, gives a light-signal. Small balloons, each containing such a thermometer, will be sent up by night; and the light will affect photographically a so-called "phototheodolite," while the height then attained will be indicated in a mechanical way. It is hoped that more exact formulæ for the decrease of temperature with height may thus be obtained.

— From the *Journal of the Anthropological Society* in Vienna, we take the following conclusions of Dr. B. Hagen, respecting the Malay peoples: Their great predilection for the sea, which makes them pray to Allah that they may die on sea, seems to render the Malay race adapted for the Polynesian and Further Indian Archipelago. The centre from which they migrated is to be sought in the highlands of West Sumatra, particularly in the old kingdom of Menang-Kabau. Thence the peoples extended slowly eastwards, — at first probably the races now to be found only in the interior of the great islands (the Battas in Sumatra, the Sundanese in Java, the Dayaks in Borneo, the Alfurus in Celebes, etc.). These "aborigines" of the islands crushed out a population already in possession, as remains of which the Negritos may be taken. The Malays in the narrower sense, occupying Sumatra, Malacca, and North Borneo, are to be regarded as the last emigration from the centre referred to, occurring from the twelfth to the fifteenth century, A.D. With the Indians and Chinese, who have been long in intercourse with the archipelago, arose mixtures and crosses, in less measure also with the Arabs. One must not therefore expect the pure racial type, especially in the coast population. The crania of the anthropological collections are too imperfectly determined in respect of their *locale* to be of any service for a judgment of the Malay peoples. Of more value are the measurements of the living, begun by Dr. Weisbach and executed by Dr. Hagen, in four hundred cases. The latter's conclusions are: (1) The peoples in the interior of Sumatra — the Battas, the Allas, and the Malays of Menang-Kabau — compose a closely allied group always in direct contrast with the hither-Indian peoples, and yet showing just as little community with the Chinese. We must therefore take them for the pure original type, characterizable as follows: small, compact, vigorous figure, of less than 1,600 millimetres average size; long arms; very short legs; very long and broad mesocephalous skull of very great compass, with high forehead; a prognathous face 10 per cent broader than long, with large mouth, and uncommonly short, flat, and broad nose with large round nostrils opening mostly frontwise, and with broad nasal root. (2) The Malays of the east coast of Sumatra and those of the coasts of Malacca indicate a much greater affinity to the Indians than to their tribal peoples of Menang-Kabau. They are plainly, therefore, thoroughly mixed with Indian blood. (3) The Javanese peoples stand much nearer to the original type of the Sumatrans than to the Malays just mentioned. They show, therefore, less mixture with Indian, but, on the other hand, more mixture with Chinese, blood; and the Javanese more so than the Sundanese.

— A London paper says that some experiments in judging distance by sound were carried out recently by one of the London brigades of the Metropolitan Volunteers. This branch of military tactics is quite a new departure. It was first explained to the men that sound travels at the rate of 1,100 yards in three seconds, and on this basis they were to estimate the distance at which some rifles were being discharged in the darkness. The answers at first were very wide of the mark, some of the men being as much as 150 yards out in their calculations. With a little practice, however, a great improvement was shown, many of the men guessing the distance exactly. The experiments are not as satisfactory as was hoped, and it is thought some time must elapse before judging distance by sound can be relied upon with any certainty.

— At the monthly meeting of the Royal Society of Tasmania on Sept. 9, the president (his Excellency Sir Robert G. C. Hamilton) said he desired to bring before the society a matter relating to the young salmon at the Salmon Ponds. These were the undoubted product of the ova brought out by Sir Thomas Brady, which had been stripped from the male and female fish and artificially fertilized, and the utmost care had been taken to keep them apart from any other fish bred in the ponds. He recently visited the ponds, accompanied by the chairman of the Fisheries Board, the secretary, and two of the members, when they carefully examined a number of the young salmon, among which they were surprised to find marked differences existing, not only in size, but in their characteristics. It has often been held, according to *Nature*, that the *Salmonidæ* caught in Tasmanian waters cannot be true *Salmo salar*, because so many of them have spots on the dorsal fin, and a tinge of yellow or orange on the adipose fin; but nearly half of the young salmon they examined, which had never left the ponds, had these characteristics. Again, many of them were almost "bull-headed" in appearance, — another characteristic which is not supposed to distinguish the true *Salmo salar*. He would suggest to the chairman of the Fisheries Board, whom he saw present, that the secretary should be asked to make a formal report of the result of this visit, and to obtain some specimens of the young fish, which could be preserved in spirits, and perhaps sent to Sir Thomas Brady to be submitted for the consideration and opinion of naturalists at home.

— British Consul Pettus of Ningpo, in his last report, says that one of the principal and perhaps most profitable industries of his consular district is the *ming fu* or cuttlefish trade. For two months, from the latter part of April until the closing days of June, the number of small and somewhat barren islands of the Chusan archipelago, situated within a radius of fifty miles of Chinhae (at the mouth of the Yung River), swarm with men engaged in the occupations of cleaning and drying the fish for the Ningpo market, and the adjacent waters are covered with boats engaged in fishing. The cuttlefish boats are from twenty-five feet to thirty feet in length, with a beam of seven feet. They are furnished with a single lug-sail, usually made of foreign cloths tanned with mangrove-bark. They are worked with two, sometimes three, oars, with which the boats are propelled with immense speed. The boats, as a rule, work in pairs, a bamboo fastened at the bows of each to keep them separated, with a space of about twenty feet between. To the bamboo is attached the large net. Others, again, catch the fish by means of a square net, fastened at the corners to the ends of two slender bamboos which cross at right angles, and sewn together in the middle. These bamboos, with the attached net, are suspended from a stout beam which projects some distance over the bow, and has fastened to the inboard end a heavy weight for facilitating the raising of the net. This is used in shallow water, and principally at night, when a fire is kept burning in a pan in the bow of the boat to attract the fish. One or two men attend to the working of this net, while the rest of the crew are employed in scooping in the fish with hand-nets. The fish are then landed, cleaned, and sun-dried, the latter operation taking about three days. The cuttlefish is called by the Chinese

uri tsê ("black thief"): *ming fu* is the commercial name of the fish when dried. The black liquid secreted by the fish was used as a substitute for ink, but was abandoned, as it faded after a lapse of a few years.

— Many late and valuable reports of ocean-currents have been received at the United States Hydrographic Office, but lack of space forbids any extended reference to them. The graphic record of the tracks of derelicts, wrecks, buoys adrift, etc., published each month on the "Pilot Chart," is itself instructive as to the general set of currents, especially in the case of a large iron buoy like that from Port Royal, S.C. Attention is called, also, to the "bottle papers" issued by the Hydrographic Office, for masters of vessels to seal up in empty bottles and throw overboard, in order, that, when found and returned, data may be obtained regarding the general drift of surface currents. This is an old plan, but one that is still used, and is thought to give results of some value when a large number of such facts are available for study. Many of these papers have been returned to that office, and the latest may be mentioned here. One was thrown overboard Dec. 30, 1888, by Chief Officer Downie (British steamship "Crown Prince") off the north-west coast of Cuba: it was picked up on the beach at Matagorda Island, Texas, Aug. 10, 1889, by the keeper of the Saluria life-saving station. Another was thrown overboard March 27, 1889, by First Officer Conklin (American steamship "Cherokee") in latitude 36° 42′ north, longitude 75° 06′ west: it was picked up on Sept. 25 by Capt. Touguerant (French brig "Bonne Joséphine") in latitude 44° 30′ north, longitude 52° 10′ west. The forms issued for this purpose are printed in six languages, and efforts are being made to give them a wide distribution.

— A lake-dwelling has been discovered in the neighborhood of Somma Lombardo, north-west of Milan, through the draining of the large turf moor of La Lagozza. The Berlin correspondent of the *Standard*, who gives an account of the discovery, says that this "relic of civilization" was found under the peat-bog and the underlying layer of mud, the former being 1 metre in thickness, and the latter 35 centimetres. The building was rectangular, 80 metres long and 30 metres broad; and between the posts, which are still standing upright, lay beams and half-burnt planks, the latter having been made by splitting the trees, and without using a saw. Some trunks still retain the stumps of their lateral projecting branches, and they have probably served the purpose of ladders. The lower end of these posts, which have been driven into the clay soil, is more or less pointed, and it can be seen from the partly still well-preserved bark that the beams and planks are of white birch, pine, fir, and larch. Among other things, were found polished stone hatchets, a few arrow-heads, flint knives, and unworked stones with traces of the action of fire.

— According to recent work of Professor H. W. Wiley, the chemist of the United States Department of Agriculture, the value of sorghum-seed as a food for man and other animals is fully equal to that of maize and oats, and but little inferior to that of wheat. The essential constituents of the cereals as food are the albuminoids and the carbohydrates. Comparing these two constituents of sorghum-seed with the other great cereals, it contains more albuminoids than either unhulled oats or maize, and only about three-fourths of a per cent less than wheat. Its contents of carbohydrates is almost identical with that of the other cereals mentioned. The glumes of the sorghum-seeds contain a coloring-matter of great intensity, and it has been thought that this substance might prove injurious to the health of animals consuming it. Professor Wiley has therefore had a careful examination made of the properties of this coloring-matter, and finds it to be a vegetable coloring-matter without noxious principles, and, as far as the investigations have extended, wholly free from tannin. This study includes only the chemical re-actions of the color, and the characteristics which distinguish it from other companion colors of a vegetable origin. Owing to the small quantity of pure color obtained, and the difficulties of complete purification, no experiments were made with regard to its dyeing qualities. The richness of the color (a deep red) would certainly point to the desirability of such experiments. In the heavier and larger hulled seeds, such as those of Deutcher's Hybrid, Early Tennessee, and the Early Amber varieties, the color seems to constitute between five and fifteen per cent of the alcoholic extract, which latter ranges from five to ten per cent of the seed. The yield of cane per acre appears to average from ten to twelve tons; and the seed-head, fifteen to twenty per cent of the cane. Assuming the seed to constitute seventy-five per cent of the head, we have three hundred pounds of seed to the ton of cane. This affords thirty pounds of extract, and three pounds of pure color, to the ton of cane, or thirty pounds per average acre. The higher the tonnage, and the darker and heavier the hull of the seed, the greater the yield of color.

— A curious instance of the vicissitudes of commerce is afforded by the change going on in the raisin trade between this country and Spain. In 1882 Malaga shipped to this country nearly a million boxes of raisins, which was about half its production for that year. Since that time the annual production in Malaga has steadily decreased, while that of California has as steadily increased, till in 1888, out of a total crop of 112,000 boxes, Malaga sent us only 700,000 boxes. It is now predicted by vine-growers that in a few years California will be shipping raisins to Spain.

— Iron buoys, being constructed so as to withstand the buffetings of the heaviest seas, are apt to remain long afloat when once they get adrift from their moorings. Although their movements are then governed by the combined influence of wind and current, the relative effects of each of these components of the force acting upon them vary more or less, according to the shape and immersion of the buoy. When a considerable portion of the moorings are still attached, the immersion is generally so great that the influence of the current largely outweighs that of the winds, and the drift of the buoy is a very fair indicator of the set of the current it has experienced. A notable instance is afforded by the mid-channel buoy from Port Royal, S.C., which went adrift in the latter part of November, 1886, and is still floating about in the North Atlantic, probably somewhere between the parallels of 35° and 45° north, and the meridians of 45° and 55° west. Eleven reports have been received thus far by the United States Hydrographic Office.

— The following is a list of the Saturday morning lectures to be given in the Law School building of Columbia College during the season of 1889–90: Nov. 16, "The Influence of Locality in American Fiction," by L. J. B. Lincoln, Esq.; Nov. 23, "Petroleum and Natural Gas" (with illustrations), by Dr. John S. Newberry; Nov. 30, "Cæsar and Cleopatra," by John William Weidemeyer, Esq.; Dec. 7, "Benjamin Franklin, America's Practical Philosopher," by Dr. Henry M. Leipziger; Dec. 14, "The Avesta and the Religion of Zoroaster," by Dr. A. V. W. Jackson; Dec. 21, "The Geological History of Man" (with illustrations), by Dr. John S. Newberry; Dec. 28, "The Relation of the Higher Education of Women to Literature in America," by L. J. B. Lincoln, Esq.; Jan. 4, 1890, "Shakspeare and Corneille," by Professor Adolphe Cohn; Jan. 11, "The Cyclades," by Dr. Louis Dyer; Jan. 18, "The Career of Leon Gambetta," by Professor Adolphe Cohn; Jan. 25, "Progress of Education in the United States," by Dr. Henry M. Leipziger; Feb. 1, "Total Solar Eclipses and What We learn from Them" (with illustrations), by Professor J. K. Rees; Feb. 8, "Where and How We remember," by Dr. M. Allen Starr; Feb. 15, "The Moon: A Study of her Surface" (with illustrations), by Professor J. K. Rees; Feb. 22, "Methods of teaching French," by Dr. B. O'Connor; March 1, "Emerson as an English Writer," by Professor T. W. Hunt; March 8, "Methods of Education," by Dr. B. O'Connor; March 15, "Words and their Abuse; from Philological, Rhetorical, and Moral View-Points," by Dr. J. D. Quackenbos; March 22, "The Poetic Edda," by Professor Charles Sprague Smith; March 29, the same subject continued; April 5, "Swinburne and the Later Lyrists," by Professor H. H. Boyesen; April 12, "George Eliot and the English Novel," by Professor H. H. Boyesen; April 19, "Shakspeare's Dramatic Construction: The Winter's Tale," by Professor T. R. Price; April 26, "Shakspeare's Verse Construction," by Professor T. R. Price; May 3, "Athenian Days," by Professor A. C. Merriam; May 10, "The Geographical Distribution of North American Plants" (illustrated by lantern projections), by Dr. N. L. Britton; May 17, "Daniel O'Connell," by Dr. William A. Dunning; May 24, "Shop-Girls and their Wages," by Dr. J. H. Hyslop.

SCIENCE:

A WEEKLY NEWSPAPER OF ALL THE ARTS AND SCIENCES.

PUBLISHED BY

N. D. C. HODGES,

47 LAFAYETTE PLACE, NEW YORK.

SUBSCRIPTIONS.—United States and Canada.....$3.50 a year.
Great Britain and Europe..... 4.50 a year.

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VOL XIV. NEW YORK, DECEMBER 6, 1889. No. 357

CONTENTS:

INFLUENCE OF FOOD, ANIMAL IDIOSYNCRASY, AND BREED ON THE COMPOSITION OF BUTTER.[1]

ONE of the fundamental principles of dairying is regard for the influence which the care of the animal, supervision of the milking, separation of the cream, ripening of the cream, churning and washing, have on the quality of butter for table use. These processes also, together with the method of packing, have a notable influence upon the preservation of the butter in a sweet state. The discussion of the above problems, however, is a thing for the practical dairyman rather than the chemist. The chemical composition of butter-fat, as influenced by the character of food received by the animal, the race of the animal, and the peculiarities of the animal, has hitherto been little studied from a chemical point of view. To the latter subject I propose to devote the following paper.

Late in February this year, I received a letter from Professor H. H. Harrington, chemist of the Experimental Station of Texas, accompanied by two samples of butter, which he asked me to examine. The following extract from Professor Harrington's letter will indicate the motive which led him to send the samples: —

"Some work in our laboratory indicates that volatile acids from the cottonseed butter are much lower than has been generally supposed. I send two samples of butter, — one from cottonseed feed, and the other from feed containing no cottonseed. If you can do me the favor of analyzing this butter, I shall send more samples from the same cows on the same feed. We hope in the near future to follow up these analyses with complete analyses of butter from different feeds, feeding two cows on cottonseed, and then changing them to other feed."

The samples sent by Mr. Harrington were small, and a complete analysis could not be made; but the results obtained are of such interest that I will communicate them at the present time, and call attention to the peculiarities noticed.

	Butter from Cottonseed.	Butter from Other Feed.
Volatile acids, No. cc N—10 BaO_2H_2 for 5 grams.....	21.00	28.50
Percentage of iodine absorbed.....	33 40	31.89
Melting-point.....	45° C.	34°.2 C.
Reduction of silver by Bechi	distinct	none

The most remarkable points connected with the analyses are as follows: 1. The low percentage of volatile acids in butter from cottonseed; 2. The phenomenally high melting-point of the butter from cottonseed; 3. The persistence of the reducing agent of the butter from cottonseed, as indicated by its action upon nitrate of silver.

The melting-point of the butter is higher than that of pure lard. The particular point to be noticed in this matter is, that in butter designed for consumption in Southern countries, or produced in Southern countries, the mixture of cottonseed with the feed of cows will tend to raise the melting-point of the butter, and render it more suitable for consumption in hot climates.

The persistence of the reducing agent is also a matter of interest. It has passed, in the samples examined, through the digestive organism of the cow, and has re-appeared in the butter with almost undiminished activity. The selective action of the digestive organs on the different glycerides contained in the food of the animal is also a matter of importance. It would be expected *a priori* that the butter from a cow fed largely on cottonseed-oil would contain more oleine and have a lower melting-point than if ordinary food were used. On the contrary, it is seen that either the more solid glycerides have been absorbed during the process of digestion, or that the oleine has undergone some distinct change in the digestive organism by which it has assimilated the qualities of the other glycerides.

From an analytical point of view, the results are of great importance, since they show that a butter derived from a cow fed on cottonseed-meal or one excreting a fat of unusual quality might be condemned as adulterated when judged alone by the amount of volatile acids present. Since cottonseed-meal is destined to be a cattle-food of great importance, especially in the southern part of the United States, this is a fact of the greatest interest to analysts.

The observation of Mayer, soon to be mentioned, that the specific gravity of butter-fat varies with its content of volatile acids, I have also verified in some cases by the determination of the specific gravity of samples of butter-fat taken from the milk of the same cows kept on the same food, but taken the following day after the samples mentioned. The specific gravity for the cotton-meal fed sample was .8929 at 99°; that for the ordinary fed sample, .8991 at 99°.

Professor Mayer's experiments were made on a single cow of a North Holland breed. From time to time during the progress of the experiments the original food was used, in order to see what effect the period of lactation would produce. The cow was fed for twelve days on each separate ration before the samples were taken. After two days more, another set of samples was taken, and then the food changed for a new experiment.

In the butter-fat the melting and solidifying points were taken, and the volatile acids determined according to the method of Reichert. The specific gravity was also determined by the Westphal method at 100°.

The rations of the cow were composed of the following ma-

[1] Abstract of a paper by H. W. Wiley, read before the Society for the Promotion of Agricultural Science at its annual meeting held in Toronto, Canada, Aug. 26, 27, 1889.

terials: ration No. 1, 15 kilograms of meadow-hay and 2 kilograms of linseed cake; No. 2, siloed grass *ad libitum*, and 2 kilograms of linseed cake; No. 3, 20 kilograms of beets, 8 kilograms of hay, and 2 kilograms of linseed cake; No. 4, pasture-grass *ad libitum*; No. 5, chopped clover with 14 per cent of other grasses *ad libitum*.

The highest melting-point observed, viz., 40.5, was from ration No. 1; and the lowest, viz., 32.5, from ration No. 5. The highest volatile acids were produced by No. 3; the lowest volatile acids were observed with ration No. 2.

The results of my analyses were obtained on the first samples of butter sent by Mr. Harrington, and were published in *Agricultural Science* for April 1, 1889, pp. 80 *et seq.* Not fully satisfied with the result of a single determination, I asked Professor Harrington to send me other samples of butter, which he did on two subsequent occasions. The analyses of the two last sets of samples sent did not fully bear out the results obtained in the first set.

The importance of a more careful study of this subject led me to institute some feeding experiments of my own, in order to unravel, if possible, the mysteries of the preceding analyses. I accordingly obtained authority from the secretary of agriculture to arrange for certain feeding experiments with Professor Alvord of the Maryland Agricultural Experiment Station. Three cows were selected for these experiments, described by Professor Alvord as follows: No. 1, full-bred Jersey; No. 2, full-bred Ayrshire; No. 3, cross-bred Jersey and Ayrshire.

These cows were kept on ordinary pasturage for ten days, and then the milk from each of the cows for three days was taken for the experiments. All the milk was subjected to the same conditions. It was set in earthen bowls in a refrigerator at 45° to 50° F., and skimmed after twelve hours. The cream was mixed and kept at 55° to 60° until the fourth day after the beginning of the milkings. The cream was then ripened in a room at 60° F. temperature for twenty-four hours. After cooling to 62° F., the cream was churned; the temperature rising from 62° F. at the beginning of the churning, to 65° at its close. The time required for each churning was twenty minutes. The three days on which the milk was saved were damp, hot days, very unfavorable for making good butter. In all cases the butter was thoroughly washed in cool well-water, made into rolls, and put in glass jars. One-half of each sample of the first lot was salted at the rate of two-thirds of an ounce of salt to one pound of butter.

After the conclusion of the first set of experiments, the cows were gradually changed to a ration of cottonseed-meal, using the commercial variety, such as is used for fertilizing purposes, as no unextracted cottonseed-meal could be obtained at this season of the year. The ration of cottonseed-meal was gradually increased, the cows finally being given all they would eat of it. The following are the facts as to the second lots. The feeding of cottonseed-meal was commenced on the 25th of July, giving but one pound at a feed at first, but constantly increasing the quantity.

During this trial the cows were turned into a small lot with very short pasturage, for exercise and access to running water. They were fed only the cottonseed-meal, and consumed the quantity stated. At the close of the trial, the Jersey and cross-bred cows were beginning to refuse the meal. The Ayrshire continued to eat all offered, and probably could have been fed twelve pounds a day; but I was afraid to give her over eleven pounds a day, and did that only twice. She later kept on at eight and ten pounds per day, while the others fell to one pound and two pounds.

In general, the data obtained corroborate the results of the first study of the samples sent by Professor Harrington. The melting-points of the butters from cows fed on cottonseed meal are markedly higher than from the other samples. There is also a markedly diminished content of volatile acids in these butters, and a lower iodine absorption power. The latter character is unlike the Harrington sample. Another characteristic phenomenon noticed in the first samples of butter is also here repeated; viz., the persistence of the reducing agent which is present in cottonseed-oil in the butter derived from animals fed thereon. The physiological importance of this phenomenon will be mentioned in another place. The most curious results, however, of these experiments is found in the increase in the butter of the glycerides having a high melting-point; in other words, the glycerides of the palmitic and stearic series. While further experiment may be necessary to show that there is a uniform diminution of volatile acids in butters from cows fed on cottonseed-meal, the fact is now most clearly established that the melting-point of such butters is uniformly higher. In regard to the absorption of iodine by the butters from cottonseed-fed cows, the results obtained are somewhat at variance with those secured by Ladd, who states that butter from cows fed on linseed-meal contained 3.5 per cent more oleine than those samples which were obtained from cows fed on bran. This conclusion of Ladd's, however, may not be the true one, since linseed-oil has an iodine absorption of about 155 per cent, and this high co-efficient may have had some influence upon the butter as regards iodine absorption. It is possible, therefore, that some of the linoleic glyceride, which has so high an iodine-absorbing power, may have found its way into the butter, thus increasing its iodine absorption.

Another important characteristic of the butters examined is seen in their abnormally low content of volatile acids. If we compare the samples from the Maryland station with those from Kansas, we have a very characteristic contrast between abnormal pure butter and normal pure butter. The two samples from Kansas show a percentage of volatile acids which is not unusually met with in samples of pure butter. On the other hand, the samples from the Maryland station show an abnormally low content of volatile acids. This percentage of volatile acids is indeed so low that these butters would be condemned as spurious if we relied upon the volatile acid test alone. It does not seem so strange, in the light of these facts, that Allen should have found abnormal Danish butters which, nevertheless, from their history, were certainly genuine.

In so far as the breed of the animal is concerned in the above experiments, it does not seem to have greatly influenced the composition of the butter. The low content of volatile acids may therefore be attributed either to the pasturage, or to the peculiarity of the animals themselves, or to the period of lactation. It would hardly seem probable, however, that three animals taken at random should have exhibited in almost the same degree the abnormal qualities indicated in the composition of the butters.

The physiological questions which are suggested by the above study are of the utmost consequence. In a paper entitled "Note on the Action of Digestive Fluids on Oil," published in *The Medical News* of July 28, 1888, I called attention to the remarkable influence exerted on a large quantity of oil in the human digestive organs. A pint of oil, presumably sweet-oil, but more likely cotton-oil, was administered to the patient for the relief of an obstruction in the gall-duct. This oil, in passing through the digestive organs, was completely decomposed mostly into fatty acid with some soap, forming an emulsion in the alimentary canal, and, being voided in the form of rounded masses of considerable consistence, was mistaken by the patient for gall-stones. This action of the digestive liquids was entirely unexpected, and seems to show that the commonly accepted notion that the fats are acted upon in the digestive organs by being emulsified, and thus absorbed into the circulatory fluids, is an erroneous one.

It is the common supposition that the facts have for a physiological function the maintenance of the animal heat of the body, and the nutrition and supply of the fatty portions thereof.

The experiments in feeding cows on cottonseed-meal would seem to indicate that the natural glycerides contained in cottonseed-meal do not appear in the butter of the cows fed thereon. If the cottonseed-oil in the food should pass unchanged into the butter, we might, it is true, have a lowering of the volatile acids; but this would be accompanied by a great increase in the iodine absorption and a marked lowering in the melting-point. It is quite certain that the glycerides of butter which yield on saponification volatile acids are not derived from similar glycerides in the food of the animal. It may also be quite true that none of the glycerides in the butter of the cow is derived from the fat of the food of the animal. It is more than likely that the fat of milk is a direct product of digestion, and is formed conjointly from the carbohydrates and the albuminoids in the cow's food. We need not, therefore, be perplexed any longer at the presence of so small a portion of stearine and so large a proportion of the butyric series of the glycerides in the fat of milk.

From the evidence already at hand, I think we would be justified

in saying that practically all the fats in milk are products of digestion, and none of them results of simple translation through the digestive organs of fats already present in food. On the other hand, we have undoubted evidence of the translation of other substances directly from the food of the cow to the butter-fat, as is shown in the presence of the aldehyde in cotton-oil, which reduces silver, in the butter of cows fed on these substances. Among other studies on the influence of the food on the composition of butter, I might cite the paper of Ladd, already noted; and also one by C. J. von Lookeren, published in the *Milch Zeitung* (No. 3, 1889, p. 47); and the paper of Mayer, published in *Die Landwirtschaftlichen Versuchs Stationen* (vol. xxxv. p. 261). These studies are of such practical interest, that it is my intention to continue them during the coming year on an extended series of feeding experiments, in which I hope to interest experimenters in different parts of the country.

THE STING OF THE JELLY-FISH.

DR. B. W. RICHARDSON writes on the above subject in the last number of the *Asclepiad*, giving a personal experience of his own. He says, —

"In my case I was caught by the shoulders and chest in the tentacles of a large medusa, and had really for a minute or two a difficulty in freeing myself. The surface of the skin touched by the tentacles began to smart at once, and, by the time I was out of the water and partly dressed, the skin was covered, over the surface attacked, with a bright erythema, accompanied with a sense of extreme heat and irritation. The sensation was much the same as that brought on by the application of a mustard poultice, except that it was not so uniformly diffused, but was rather in the form of wheals in slightly raised lines, with a considerable number of points at which the tingling and heat were most severe. Unfortunately, I had no clinical thermometer by me with which to take the local temperature, but, judging by the touch of the hand, the local temperature was raised at least two or three degrees. The redness and irritation lasted seven hours, and did not absolutely subside until after a night's rest; but, during the time it was on in the acute form, it was soothed considerably by the application of water, rendered alkaline by common washing soda in the proportion of an ounce of the soda to about two quarts of water.

"A friend of the writer suffered far more severely. He was bathing where a number of jelly-fish were present, and got so entangled amongst them, that, as he said, he was 'stung over almost all the surface of his body.' He suffered from an acute erythematous eruption, which lasted over sixteen hours, attended with two degrees of general fever, and followed by malaise that lasted three days.

"A still more important case happened in a very singular manner to another friend and patient. I had gone down to a bathing-place in the summer of 1872, not knowing that my friend was there. I had not been on the spot two hours, when a messenger came to me, asking if I would go at once to Mr. G., the friend in question, because he had been 'stung in the throat by a jelly-fish, and they were afraid he would not live.' On reaching my friend, who had accidentally heard I was near to him, I learned that about two hours before, while he had been floating on his back in the sea, with his mouth open, the tentacles of a jelly-fish swept into his mouth, and stung him severely in the back of the throat. There could be no doubt about the mischief, for the throat over the whole of the pharynx was intensely red, and the surface was rough and raised. With this condition there were considerable heat and irritation, amounting to acute pain, and attended with inability to swallow any thing except fluids cooled with iced water. The idea of extreme danger was present in the mind of the sufferer, and I believe my firm assurance that he would take no harm contributed as much to the recovery that succeeded as the simple alkaline remedies which formed the chief part of the medical treatment. In this case also there was a rise of two degrees of temperature, and during convalescence there was marked depression of both mind and body for a period of two or three days.

"In describing these phenomena," he adds, "I have used the ordinary word 'sting' for the want of one more accurate. Really, I do not know whether it is a sting, like that of a wasp or a nettle, that is inflicted, or whether a secretion, acrid in kind, is thrown upon the surface, and acts directly as an irritant fluid. On the whole, I suspect it is a fluid, or organic acid, which is the cause of the irritation. For the resultant erythema, local alkaline treatment is particularly effective. In the throat case, bicarbonate of soda with *mel boracis* proved very grateful and useful."

MENTAL SCIENCE.

The Energy and Rapidity of Voluntary Movements.[1]

M. FÉRÉ, whose volume upon the relations of sensation and movement, upon the phases of hypnotism and kindred topics, has given him a deserved reputation, has recently investigated the relation between the energy or physical power at the disposal of the individual and the rapidity of his re-actions to simple physical processes. His main thesis is, that great energy and great quickness of movements are concomitant, and vary in the same way under similar circumstances. He has studied this relation among the hysterical and epileptic (as typical instances of abnormal sensori-motor organisms) as well as in normal individuals.

M. Féré had shown that in hysteria the influence of certain emotions, pleasant in their nature, was to increase the maximum power of exertion, as tested by the "squeezing" of a dynamometer, which action he terms "sthenic;" while opposite emotions decrease such power, and are "asthenic."[2] He now studies the variations in the re-action times to an electrical shock under the same influences, and the concomitant variation in dynamometric power. In five subjects re-acting from the forehead and the back of the hand, both on the right side and on the left, the average re-action times were, T .61, M .61, V .42, R .28, and B .27 of a second, when the dynamometer registered respectively, T, 24; M, 24; V, 28; R, 28; and B, 29. Furthermore, the side of the body from which the re-action is quickest (the subjects are affected with partial anæsthesia) also claims the hand with greatest dynamometric force.

If these subjects are put into the somnambulic stage of hypnotism, the effect upon the re-action time may be either to shorten it or lengthen it, or leave it unaltered; but in every case the power of the maximum contraction is affected in the same way. The re-action times are, for T .61, for V .61, for R .35, for B .25, for M .20, of a second; and the strength of squeeze respectively, 24, 25, 30, 36, 40. Under the influence of an "asthenic" or strength-depriving unpleasant emotion, such as fear, B's re-action time increased from the normal of .29 to .44 of a second, and his muscular force decreased from 29 to 20; M's re-action time of .61 becomes .65 of a second, and his dynamometric record of 24 becomes 25. Similar changes for V are from .42 to .51 of a second, and from 28 to 24; for R, from .28 to .45 of a second, and from 28 to 16; for T, from .61 to .62 of a second, and from 24 to 30. We notice the individual variations, but in general the law is maintained. Under the influence of a "sthenic" or strength-giving emotion, the re-action times decreased and the squeeze increases as follows: for B, .13 of a second and 40; for M, .16 of a second and 46; for V, .28 of a second and 37; for R, .14 of a second and 42; for T, .19 of a second and 38. Essentially similar results are shown for two hysterical patients re-acting to sound instead of to touch impressions. M. Féré records the form of the contraction of the hand, and finds, that, when the effort is powerful and the re-action quick, the curve of contraction rises suddenly, while in the opposite case it rises slowly. He notes, too, many other mainly physiological conditions into which we cannot here enter, but all of which go to show that the speed of re-action times depends upon the rate at which the nutritive processes of circulation, etc., proceed. Essentially similar results were obtained in epileptics. In one case the re-action time to a touch impression was .34 of a second; to a sound impression, .28 in the normal condition; one hour after an

[1] Revue Philosophique, No. 7, 1889.

[2] It is interesting to compare this action with the re-enforcement of the patellar-tendon reflex or knee-jerk by similar means. Any impressive sensation will cause an increase in the response to a simple blow below the knee. Both may be regarded as very sensitive and quickly registering indices of the effect of stimuli upon the nervous system, and have the extreme value that the great rarity of such indications gives them (see Lombard, in Vol. I. No. 1. of the American Journal of Psychology).

epileptic seizure it was .50 of a second for touch, and .37 for sound. In another patient the re-action times were .35 of a second for touch and .30 for hearing three hours after an attack, as against .21 of a second and .16 normally. A third patient, whose normal re-action times were .28 of a second (touch) and .34 of a second (sound), two hours after a seizure, re-acted in .40 of a second to touch and .37 of a second to a sound. The same patient, seventy-two hours after the last of fifteen successive attacks, required 1.11 seconds to re-act to touch, and 1.25 seconds to re-act to a sound. In an independent research, M. Féré had shown that in the average of twenty cases the dynamometric power was reduced to 45 per cent of its normal value immediately after a seizure, to 33 per cent after one-quarter of an hour, to 25 per cent after an interval of one half-hour, and to 17 per cent after an interval of three-quarters of an hour. Apart from special relations of the nature of the seizure to the diminution in muscular power, the general thesis of M. Féré is well borne out by these facts.

In normal individuals the same relations can be demonstrated, though the contrasts are not as sharp. Fatigue diminishes muscular force, and increases the times of re-action. Intelligent persons, speaking generally, have a short re-action time and a high dynamometric pressure. In order to study in closer detail the relation of re action time and motor power in special motor groups, M. Féré had constructed a dynamometer in which the pressure of each finger was recorded separately. With this apparatus M. Féré was able to establish that the movements of flexion were from three to ten times as powerful as those of extension; that the power of different fingers varies with different individuals, and stands in relation to the profession of the individual, the third and fourth fingers being especially strong in piano-players; and that intellectual persons have an especially strong thumb, an essentially human movement.

	Flexion.		Extension.	
	Dynamometer.	Re-action Time. Seconds.	Dynamometer.	Re-action Time. Seconds.
Thumb	4.2	.163	1 2	.190
Forefinger.....	4.0	.191	1.0	.261
Middle finger...	3 5	.193	.9	.280
Third finger....	2.0	.201	.6	.299
Little finger ..	1.9	.203	.4	.310
Thumb.....	2.7	.230	1.0	.335
Forefinger.....	3.3	.160	1.1	.260
Middle finger...	2.2	.180	.4	.277
Third finger...	2.0	.195	.35	296
Little finger ..	1 8	.246	.3	.309
Thumb	4.1	.170	1.1	.220
Forefinger.....	3.0	.191	.6	.210
Middle finger ..	3.2	.182	.7	.190
Third finger ...	2.2	.181	.7	.183
Little finger..	5.1	.171	.5	.142
Thumb..... ...	2.8	.282	.6	.340
Forefinger.....	2 6	.359	.4	.516
Middle finger..	2.5	.346	.3	.515
Third finger ...	1.7	.436	.1	.639
Little finger....	1.4	.515	.2	.517

The first three records were obtained from officials of the hospital, and exhibited very fairly the points in discussion, while the third subject is also a pianist, and shows a remarkable power of flexion of the little finger as well as a quick re-action time for both flexion and extension of this finger. The fourth record is of an intelligent epileptic patient. We see, that, while the dynamometer shows movements of flexion far superior to those of extension, the re-action times show only a slight superiority, and that exercise seems to increase not only the power of flexion, but the speed of extension. If we make separate observations on the right and left hands, we will find that the preferred hand presses more strongly and re-acts more quickly than the other hand.

The same method can be applied to the movement of other organs. The energy of extension of the tongue has been measured, and varies in normal subjects from 500 to 850 grams. In deaf-mutes and patients afflicted with aphasia it may be as low as 100 grams. That the energy of this movement is related to the re-action time is shown in the following results: F (a normal subject) moves the tongue with a force of 850 grams, and performs this motion in .13 of a second; L (also normal), 400 grams and .15 of a second; J (partially aphasic), 300 grams and .30 of a second; F (a stammerer), 200 grams and .33 of a second.

That nutritive processes play an important part in these movements is more than likely. Cold retards and heat accelerates the re-action times. The following table shows the effect of warming upon the re-action time in movements of flexion and extension of the five fingers: —

	Flexion.		Extension.		
	Before Warming.	After Warming.	Before Warming.	After Warming.	
Thumb	.346	.233	.362	.194	The movements of extension, and especially those ordinarily the slowest, seem to be most benefited by this additional warmth.
Forefinger..... ..	.269	.234	.270	.186	
Middle finger..... .	.266	.261	.280	.201	
Third finger.....	.255	.239	.320	.250	
Little finger.....	.283	.237	.312	220	

This research, though incomplete, and founded upon rather few experiments with each subject, yet admirably suggests the close relations that exist between the motor, sensory, and nutritive functions of the psycho-physical organism. As our knowledge of this relation becomes more and more exact, the possibilities of utilizing such knowledge for making the elementary processes of knowledge and action easier and quicker, become more and more real.

RAPIDITY OF MOVEMENTS. — A pianist, in playing a presto of Mendelssohn, played 5,595 notes in four minutes and three seconds. The striking of each of these notes, it has been estimated, involved two movements of the finger, and possibly more. Again, the movements of the wrists, elbows, and arms can scarcely be less than one movement for each note. As twenty-four notes were played each second, and each involves three movements, we would have seventy-two voluntary movements per second. Again, the place, the force, the time, and the duration of each of these movements, was controlled. All these motor re-actions were conditioned upon a knowledge of the position of each finger of each hand before it was moved, while moving it, as well as of the auditory effect in force and pitch, all of which involves at least equally rapid sensory transmissions. If we add to this the work of the memory in placing the notes in their proper position, as well as the fact that the performer at the same time participates in the emotions the selection describes, and feels the strength and weaknesses of the performance, we arrive at a truly bewildering network of afferent and efferent impulses, coursing along at inconceivably rapid rates. Such estimates show, too, that we are capable of doing many things at once. The mind is not a unit, but is composed of higher and lower centres, the available fund of attention being distributable among them.

BOOK-REVIEWS.

A Treatise on Linear Differential Equations. By THOMAS CRAIG. New York, Wiley. 8°.

THE theory of differential equations has undergone within the last thirty years a most fundamental change. The object of the older theory was to integrate a given differential equation "in finite

form;" that is to say, by means of the elementary functions of analysis. But though the importance of this problem for practical purposes must be acknowledged, the problem itself, understood in this form, is in general an impossible one.

The modern theory, inaugurated by Briot and Bouquet's and Fuchs's discoveries, has reversed the whole problem. It considers the differential equation (together with a proper number of initial conditions) as defining a function, and proposes to derive directly from the differential equation the characteristic properties of its integrals, true to the general principle of the theory of functions, that the essential thing about a function is not its form, which usually may be varied in many ways, but the totality of its characteristic properties.

It is in particular the theory of linear differential equations that has been very fully considered from this standpoint; and there is scarcely any branch of mathematical science that has attracted a more general attention in our day, and in which more important discoveries have been made, than the theory of linear differential equations. Still every one who wished to become familiar with it, and who had to work his way through the vast and difficult literature on the subject, has keenly felt the want of a systematic exposition uniting the numerous researches scattered in the different mathematical journals and publications of learned societies.

To meet this want, and to give an account of the theory as it stands to-day, is the object of the "Treatise on Linear Differential Equations," by Professor Thomas Craig of Johns Hopkins University. The first volume, which is to be followed by a second one, is entitled "Equations with Uniform Co-efficients," and deals principally with Fuchs's theory and the investigations immediately connected with it. The rich material has been carefully sifted, and is presented in a clear and intelligible language in the most natural order of ideas.

An introductory chapter gives the general properties of a system of linear differential equations of a more formal character, among others the well-known theorems on systems of independent particular integrals.

Next follows an elegant exposition of the theory of linear differential equations with constant co-efficients, where the reader will find, besides Euler's solution, an account of various ingenious methods due to Cauchy, Hermite, and others.

After these preparations, we are led, in Chapter III., into the very centre of the modern theory; viz., the determination of the form of the integrals in the region of a critical point. It is first shown, that, if the differential equation be written in the form

$$\frac{d^n y}{dx^n} + p_1 \frac{d^{n-1} y}{dx^{n-1}} + \quad . \quad . \quad . \quad + p_n y = 0,$$

the critical points of any one of its integrals are always found among the critical points of the system of co-efficients, $p_1, p_2 \ldots p_n$. Then Fuchs's theorems concerning the form of the integrals in the region of a critical point are developed with all the details about "groups of integrals" added by Hamburger, Floquet, and others.

A particular integral is said to be regular in a critical point a, if it remains finite for $x=a$ after multiplication by some proper power of $x-a$; and, in order that all the integrals may be regular in a, it is necessary and sufficient that $(x-a)^\alpha p^\alpha$ $(\alpha=1, 2 \ldots n)$ be holomorphic in a. Chapter IV. contains an account of Frobenius's elegant treatment of this case, and gives a simple criterion for the non-appearance of logarithms.

The next chapters are devoted to that important class of differential equations (called regular equations) all of whose integrals are regular in all the critical points; and the fertility of the general methods is abundantly shown in the application to the equation of the second order, in particular that with three critical points, which, on account of its high importance, is very fully treated, with many interesting results concerning Riemann's P-function, spherical harmonics, Bessell's functions, etc.

The differential equation of the hypergeometric series, to which the above equation can always be reduced, takes such a central place in recent mathematical researches that it well deserves to be considered with all detail, as is done in Chapter VII., which contains a reproduction of Goursat's "Thesis on the Hypergeometric Series."

The theory of irregular integrals is still in a very imperfect state. Chapter IX. gives an account of Frobenius's and Thomé's researches, and the same subject is treated in Chapter X. by the elegant method of decomposition of a differential quantic into symbolic prime factors. Interesting special classes of irregular equations will be found in the chapters on Halphen's equations, and on equations with doubly periodic co-efficients.

The two remaining chapters might, it seems to us, as well have been reserved for the second volume, where the same subjects will be more fully dwelt upon. Still the two conceptions of group and of invariant of a differential equation which they develop are of so fundamental importance that they can scarcely be introduced too soon.

If the co efficients of a linear differential equation are uniform functions of x, any system of n independent particular integrals submit to a homogeneous linear substitution when the variable point x describes any closed path in its plane. The entire system of substitutions obtained in this way forms a group, called the "group of the differential equation."

The notion of "invariant" of a linear differential equation, on the other hand, arises when the given equation is transformed into another of the same form by the introduction of two new variables, and its definition is analogous to that of an invariant of an algebraic quantic.

We must confine ourselves to these few indications, and refer the reader to the book itself for further information. Only then will he obtain an adequate idea of the thoroughness and completeness with which the subject has been treated. As far as we are able to judge, no investigation of any importance has been omitted, and the justice and conscientiousness with which continually reference to the original papers is given are a characteristic feature of this most valuable book, which, we are sure, will contribute a great deal to spread the knowledge of this important discipline.

We look forward with much interest to the appearance of the second volume, which will contain, among other things, an exposition of the theory of linear differential equations with algebraic integrals, and of Poincaré's theory of Fuchsian groups and Fuchsian functions.

AMONG THE PUBLISHERS.

THE Bulletin of the Ohio Agricultural Experiment Station for October, 1889, is Vol. I, No. 1 of a technical series, and contains three articles by Clarence M. Weed, — "Preparatory Stages of the 20-Spotted Ladybird," "Studies in Pond Life," and "A Partial Bibliography of Insects affecting Clover."

— The opening article in the December number of *Outing*, "Wabun Anung," by F. Houghton, is a clear description of a tour in the region of the Great Lakes. Another article is the "Merits and Defects of the National Guard," by Lieut. W. R. Hamilton. We note further the "Game of Curling," by James Hedley; "Wheeling through the Land of Evangeline;" "Game Protection;" "Instantaneous Photography," by W. I. Lincoln Adams; "Women and their Guns;" "The Yale Stroke;" "Alligator Shooting in Florida;" and "Na-ma-go-os," a fishing sketch.

— John Wiley & Sons have just published "A Hand-Book for Sugar Manufacturers and their Chemists," by Guilford L. Spencer of the United States Department of Agriculture. The volume contains practical instruction in sugar-house control, the diffusion process, selected methods of analysis, reference tables, etc. The essential requirements of a thorough chemical control and superintendence of a sugar-factory are carefully described, and only such analytical processes are given as relate to sugar-house products and the waste residues when necessary to a complete control. Technical chemical terms have as far as possible been avoided. The little book ought to stimulate our sugar-manufacturers and their chemists to more extensive investigations and more thorough work.

— Messrs. Ginn & Co. announce for publication early in December the first volume of a serial entitled "Harvard Studies in Classical Philology," edited by a committee of the classical instructors of Harvard University. It is the expectation that one volume,

Publications received at Editor's Office,

Nov. 25-30.

BAGEHOT, Walter, The Works of. Ed. by Forrest Morgan. 5 vols. Hartford. Conn., Travelers Ins. Co. 2625 p. 8°.

BECKER, G. F. Geology of the Quicksilver Deposits of the Pacific Slope, with an Atlas. Washington, Government. 486 p. 4°.

CHURCH, A. J. The Story of Early Britain. New York, Putnam; London, T. Fisher Unwin. 382 p 12°. $1.50.

HUBERT, P. G., jun. Liberty and a Living. New York and London, Putnam. 239 p. 16°. $1.

JACOBS, H. B., and BROWER, A. L. The Graphic System of Object Drawing. Nos. 1-4. New York, A. Lovell & Co. 92 p. 7 by 8⅝ inches.

——Same. Nos. 5 and 6. New York, A. Lovell & Co. 43 p. 9¼ by 11¾ inches.

——Hand-Book to accompany The Graphic System of Object Drawing. New York, A. Lovell & Co 50 p. 12°.

——Notes to accompany Books 5 and 6 of The Graphic System of Object Drawing. New York, A Lovell & Co. 11 p. 12°.

NEWBERRY, J. S. Fossil Fishes and Fossil Plants of the Triassic Rocks of New Jersey and the Connecticut Valley. Washington, Government. 152 p. 4°.

POYSER, A. W. Magnetism and Electricity. London and New York, Longmans, Green, & Co. 247 p. 12°. 80 cents.

RICKS, G. Natural History Object Lessons. Boston, Heath. 352 p. 12°. $1.35.

RIPPER, W. Steam. London and New York, Longmans, Green, & Co. 202 p. 12°. 80 cents.

TABER, C. A. M. Winds, Ocean Currents, and Ice Periods. Boston, G. H. Ellis. 86 p. 12°.

U. S. ARMY. Annual Report of the Chief of Engineers, 1889. Washington, Government. 429 p 8°.

WRIGHT, M. R. Elementary Physics. London and New York, Longmans, Green, & Co. 248 p. 12°. 80 cents.

containing about two hundred octavo pages, will be issued each year. The contributors will be, for the most part, instructors in the university, or graduates of the same, but contributions of other scholars will not be absolutely excluded. Any correspondence respecting contributions should be addressed to Professor James B. Greenough, Professor John Williams White, or Professor F. D. Allen, Cambridge, Mass. Subscriptions (one dollar, four marks, or five francs a volume) may be sent to Otto Harrassowitz Leipzig, Germany; Ginn & Co., 57 & 59 Ludgate Hill, London E.C., England; or the latter firm at Boston, New York, or Chicago

— With the December number the *Magazine of American History* completes its twenty-second volume. The frontispiece to the current issue is a portrait of Lord Brougham; and the opening paper by the editor is a sketch of his early career during the infancy of our Republic, with pen-pictures of his contemporaries and surroundings, the establishment of the *Edinburgh Review*, and the marriage of its editor in New York City. The second illustrated paper is a "Tribute to Hooper C. Van Voorst," the late president of the Holland Society, by George W. Van Siclen. The third contribution is "The Story of Brave, Beautiful Margaret Schuyler," an historic ballad from the pen of Judge Charles C Nott of Washington. Curiously interesting is the article following, of R. W. Shufeldt, "The Drawings of a Navajo Artist," illustrated with the Indian pencil; as is also the "Acrostic by John Quincy Adams," in facsimile, from Ella M. M. Nave. "The Sciota Purchase in 1787," by Col. E. C. Dawes of Cincinnati, and the "Private Contract Provision in Ordinance of 1787," by Hon. W. P. Cutler, are important contributions to the number. These are ably written, and will doubtless serve to correct many errors in recent histories of Ohio. "Joseph Hawley, the Northampton Statesman," is the theme of a paper by Charles Lyman Shaw; "Fort Perrot, Wisconsin," is from T. H. Kirk; "First Editions of the Bible printed in America," from Clement Furgeson; and "Gen. Grant and the French," from Theodore Stanton of Paris. This magazine is steadily exerting an educational and healthful influence in all departments of literature and study.

LETTERS TO THE EDITOR.

***Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

The editor will be glad to publish any queries consonant with the character of the journal.

On request, twenty copies of the number containing his communication will be furnished free to any correspondent.

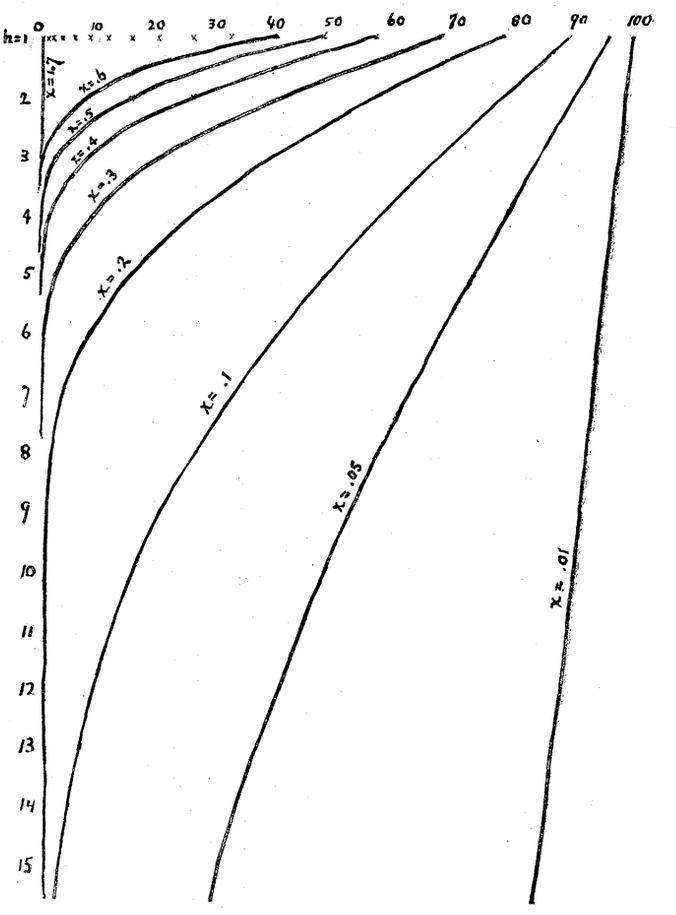
Intelligence of Ants.

I SEND you the following regarding ants, by Mr. W. E. Bosworth of this city, written out at my request, which seems to me an interesting and at the same time somewhat rare observation. It is almost exactly similar to the account by McCook of the sleeping of harvesting ants, of Texas, as quoted in G. J. Romanes' "Animal Intelligence," p. 84. I do not recall any other instance given of the sleeping of ants. "At different times, and for more than one season, I was favorably situated to see the movements of quite a large colony of small black ants, as they passed to and fro in their busy haste over a board floor, going, as I supposed, for their supply of water, which was in the direction of a small stream close by. While watching their quick, eager movements, there were several along the line that attracted my attention, as they remained in one place so long that I concluded they must be dead; and although they were directly on the line of march, and in the way of the others, these passed on, paying no attention to them whatever. At another time I noticed that one of the ants supposed to be dead got up, and walked off as lively as the rest; and, while watching this one, another one close by began to slow up, seemed to totter in his gait, and finally came to a dead halt. After seeing this, it occurred to me that the one had just waked up, and the other had just gone to sleep. In order to test the matter, and gratify my curiosity, I concluded to experiment on some of them. With a fine straw they were gently rubbed on the back. This mild treatment did not make the slightest impression on them; but a sharp push seemed to take them completely by surprise, and to fully arouse them. For an instant they seemed lost, circulating around, running up and down, but finally starting off with the rest. This was repeatedly tried with the same result. Their movements on being disturbed very forcibly reminded me of a child when suddenly waked out of sound sleep." JAS. LEWIS HOWE.

Louisville, Ky., Nov. 21.

Galton's Bodily Efficiency Diagram and the Marking System.

FRANCIS GALTON'S bodily efficiency diagrams (*Nature*, Oct. 31, 1889) can evidently be applied to the rating, on an arbitrary scale, of all sorts of things besides physical measurements and tests. For instance: the annexed diagram represents, by Galton's method, the rating of errors as the measure of precision gradually rises. The data were taken from the table on p. 12 of Merriman's "Least Squares" (first edition). The curves are drawn in general for values of x differing by .1; the ordinates in all cases being values of h, and the abscissas the rating on a scale of 100. The diagram shows at a glance how in all cases the rating of the same



error decreases as the measure of precision increases, but how, for very large and very small errors (see the curves $x = .01$ and $x = 1.7$), the measure of precision affects the rating little.

The rating of any errors which are distributed roughly according to the probability curve, as they are, for instance, in every school examination, ought to conform in general to these curves, and I think teachers usually strive to have it do so, either consciously or instinctively. If the error is flagrant, the question containing it is marked zero, or nearly so. The discrepancies in the marks of different teachers, or in the marks of the same teacher at different times, seem due to the different measures of precision mentally adopted. The curves show that these variations of the measure of precision affect most the rating of mediocre work, and this also accords with the experience of teachers. Now, of course the errors of each scholar have their own probability curve and their own value of h, which perhaps might be calculated from a long series of examination-papers. It would probably differ for different subjects. The custom, then, of marking good and poor scholars on different scales has a reason. The only question is, whether these scales can be so systematized as to be quite just, and whether it

would not be better to assume, in rating, the same measure of precision for all.

At any rate, the study of these curves cannot help being of interest to teachers. ARTHUR E. BOSTWICK.

Montclair, N.J., Nov. 22.

Cave-Air for Ventilation.

COL. CRUMP'S effort to utilize cave-air has a personal interest. I warm my dwelling with furnace-heat, and in place of taking in air through a basement window, as is usual, I placé an intake pipe or tube (I use stone pipe) under a porch upon the south side of the house, which passes under ground eight feet, around the building to the north side, beneath the cellar wall and below the cellar floor, to the furnace, — a length of about a hundred feet. The size of this pipe should be the same as the chimney. This must depend upon the size of the building to be warmed. My chimney is eighteen inches clear space. My house contains twelve rooms. This chimney is sufficient to ventilate the house, and carry off the smoke from the furnace. Sometimes it is necessary to build a small fire in the bottom of the chimney, where provision is made for such purpose. Ventilating-tubes are placed under the floor from the outside corners of the rooms, to draw off the cold air on the floor, which is constantly being replaced by the warmed air from the ceiling. Now, the advantage of this improvement in the use of cave-air is that in cold weather a modified air comes into the furnace. In hot weather, using the same apparatus to cool the air before coming into the house, the windows should be closed. The difference of temperature is from ten to fifteen degrees in the shade.

I have used it successfully for two summers, and I know of no system so satisfactory. W. H. LEONARD.

Minneapolis, Nov. 18.

INDUSTRIAL NOTES.

Elektron Manufacturing Company.

A FEW weeks ago fire destroyed the factory of the Elektron Manufacturing Company of Brooklyn, whose Perret motors and dynamos were described in *Science* recently. The company at once secured a larger factory, at 79 and 81 Washington Street, near the bridge, equipped it with a complete installation of special tools and machinery, and are doing their best to catch up with their orders, which had fallen far behind during their enforced idleness.

Electrical Accumulators.

IN the suit of The Electrical Accumulator Company *vs.* The Gibson Electric Company in the United States Circuit Court for the Southern District of New York, which was instituted in February last, the complainants have recently moved for a preliminary injunction, and Judge Lacombe on Friday last granted the motion, and the injunction issued. The complainants' testimony shows conclusively that the Gibson Company have continuously infringed the Faure patent, and that their various modifications are infringements.

CALENDAR OF SOCIETIES.

Biological Society, Washington.

Nov. 30. — Theobald Smith, Preliminary Observations on the Micro-organisms of Texas Fever; D. E. Salmon, General Remarks on Texas Fever, illustrated by Lantern-Slides; C. D. Walcott, Description of a New Genus and Species of Inarticulate Brachiopod from the Trenton Limestone; Frank Baker, An Undescribed Muscle of the Infraclavicular Region in Man.

Engineers' Club, Philadelphia.

Nov. 16. — Mr. William B. Spence exhibited a working model of the Rimmer oxidizer, a filtering-material, which he described, and for which he made various claims as to its utility in the purification of water by oxidation. He stated that the material used is an English invention, and that it is known as "magnetic carbide of iron." It consists of a mixture of granulated iron ore and carbon. The iron ore is said to be cleaned of all natural impurities by a patented process. It is then chemically treated at a certain temperature. It is claimed that this material will absorb and retain a large quantity of oxygen from the atmosphere. In use it is charged daily with atmospheric air, when, it is claimed, a re-action takes place with the impurities which have accumulated in the filtering material, and that the result passes off in the form of gas. It is claimed that metals in solution in the water will form insoluble oxides. The upper layer of the filtering plant consists of sand, for the removal of suspended matter by mechanical filtration, and the lower layer of the material above described for the chemical removal of impurities in solution. It is claimed that both vegetable and animal organic impurities and metallic contaminations are entirely removed by this process. The following tests were made in the presence of the meeting. The filtering materials were contained in a large glass funnel. Water, as muddy as that of the Schuylkill River during freshets, was made apparently perfectly clear. A solution of sulphate of iron in water was made, and a portion thereof passed through the filter. The unfiltered and filtered portions were then tested with ferrocyanide of potassium. The former showed a distinct blue tint, while the latter remained perfectly clear, showing the elimination of the iron. Lead and copper tests seemed to show the same results. To illustrate the destruction of organic matter, sulphide of ammonia, sulphide of iron, and acetate of lead were added to water, making a compound which was almost black, and of strong and unpleasant odor. After filtration, it was clear, and tests seemed to fail to discover any trace of the impurities. A mixture of copying-ink and water was passed through the filter with the same results.

Boston Society of Natural History.

Dec. 4. — R. T. Jackson, Certain Points in the Development of the Mollusca; J. Walter Fewkes, A Remarkable Instance of Rock Excavation by Sea-Urchins.

Engineers' Club, St. Louis.

Nov. 20. — Mr. Robert Moore addressed the club on the subject of "Railway Culverts." This question was usually given too little attention. The speaker described the various forms of culverts used, with the advantages and disadvantages of each, also stated the methods of determining the size and best mode of construction. He stated that sewer-pipe, while admirably adapted for small culverts, should not be used over fifteen inches in diameter. For larger sizes, cast-iron pipe answered well. Cast-iron pipe which had been condemned for heavy pressures was being largely used for this purpose. Mr. Moore also presented a diagram, based on Kutter's formula, using a value of 17 for n, bearing in mind that one inch of rainfall per hour is equivalent to one cubic foot per acre per second. In the discussion, Mr. Ferguson described a number of practical points of difficulty he had met with. The discussion was also participated in by Messrs. J. A. and W. L. Seddon, M. L. Holman, and A. W. Hubbard. Mr. Holman stated that iron pipe for this purpose was being made as large as six feet in diameter and ten feet long, being lighter and of poorer quality than the pipe used for water-service.

Exchanges.

[Free of charge to all, if of satisfactory character. Address N. D. C. Hodges, 47 Lafayette Place, New York.]

Morris's "British Butterflies," Morris's "Nests and Eggs of British Birds," Bree's "Birds of Europe" (all colored plates), and other natural history, in exchange for Shakesperiana; either books pamphlets, engravings, or cuttings. — J. D. Barnett, Box 735, Stratford, Canada.

I have *Anodonta opalina* (Weatherby), and many other species of shells from the noted Koshkonong Lake and vicinity, also from Western New York, and fossils from the Marcellus shale of New York, which I would be glad to exchange for specimens of scientific value of any kind. I would also like to correspond with persons interested in the collection, sale, or exchange of Indian relics.— D. E. Willard, Albion Academy, Albion, Wis.

Will exchange "Princeton Review" for 1883, Hugh Miller's works on geology and other scientific works, for back numbers of "The Auk," "American Naturalist," or other scientific periodicals or books. Write. — J. M. Keck, Chardon, Ohio.

"I wish to exchange *Lepidoptera* with parties in the eastern and southern states. I will send western species for those found in other localities."— P. C. Truman, Volga, Brookings Co., Dakota.

Shells and curiosities for marine shells, curiosities or minerals address W. F. Lerch, No. 308 East Fourth St., Davenport, Iowa.

A collection of fifty unclassified shells for the best offer in bird skins; also skins of California birds for those of birds of other localities. Address Th. E. Slevin, 2413 Sacramento St., San Francisco, Cal.

I have forty varieties of birds' eggs, side blown, first class, in sets, with full data, which I will exchange for books, scientific journals, shells, and curios. Write me, stating what you have to offer. — Dr. W. S. Strode, Bernadotte, Fulton County, Ill.

I want to correspond and exchange with a collector of beetles in Texas or Florida. — Wm. D. Richardson, P.O. Box 223, Fredericksburg, Virginia.

100 botanical specimens and analyses for exchange. Send list of those desired and those which can be furnished, and receive a similar list in return. Also cabinet specimens and curiosities for the same. Scientific correspondence solicited. — E. E. Bogue, Orwell, Ashta. County, O.

I will sell to chapters or individual members of the Agassiz Association, 25 fine specimens of fossil plants from the Dakota group (cretaceous), correctly named, for $2.50. Send post-office order to Charles H. Sternberg (author "Young Fossil-Hunters"), 1033 Kentucky Street, Lawrence, Kan.

Any one who has a botanical box in good condition wil please write. I will offer about 30 specimens in exchange. — C. B Haskell, Box 826, Kennebunk, Me.

Lead, zinc, mundic, and calcite. — Lulu Hay, secretary Chapter 350, Carthage, Mo.

Drawings from nature — animals, birds, insects, and plants — to exchange for insects for cabinet; or I will send them in sets of ten each for ten cents in stamps. My drawings in botany are in detail, showing plant, leaves, flowers, seed, stamens, pistils, etc. — Alda M. Sharp, Gladbrook, Io.

A few first-class mounted birds, for first-class birds' eggs of any kind in sets. — J. P. Babbitt, secretary Chapter 755. 10 Hodges Avenue, Taunton, Mass.

California onyx. for minerals and coins not in my collection. — W. C. Thompson, 612 East 141st Street, New York, N.Y.

One mounted single achromatic photographic lens for making 4 × 5 pictures, in excellent condition; also one "new model" double dry-plate holder (4" × 5"), for fine geological or mineralogical specimens, properly classified. — Charles E. Frick, 1019 West Lehigh Avenue, Philadelphia, Penn.

The undersigned wishes to make arrangements for the exchange of *Lepidoptera* of eastern Pennsylvania for those from other localities. All my specimens are named and in good condition. — Charles S. Westcott, 613 North 17th Street, Philadelphia, Penn.